Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" *To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, MAY 2, 1901.

THE PHYSICIAN AS PHYSIOLOGIST.

A Contribution to the Study of the Blood and Blood-pressure. By George Oliver, M.D. London, F.R.C.P. Pp. xii + 276. (London: H. K. Lewis, 1901.) Price 7*s.* 6*d.*

IT is to be feared that most medical men who are engaged in the active practice of their profession have little idea of making a practical application of the knowledge of physiology which they were at so great pains to acquire during the student period of their career. There are, however, many exceptions, and prominent amongst them the author of the little work which it is our present purpose to notice. Dr. George Oliver is fortunate in that his sphere of practice has given him leisure during several months in each year to study at length such physiological problems as have appeared to him to bear more directly upon the affections which he has been mainly called upon to treat, and the result of his studies has been a not immaterial addition to our knowledge of the physiology of the circulation and of the blood. Such addition has been obtained largely by the devising of methods which have more immediate applicability to the human subject than those which are in common use in the physiological laboratory. Not that Dr. Oliver has neglected the more strictly scientific study of physiological questions; as is evidenced by his well-known investigations into the functions of the ductless glands. But in the book before us the methods which are described are solely those which, whilst maintaining a high standard of scientific value, have a direct clinical application, and the observations which are given are the results of such application in the normal and occasionally in the abnormal subject, extending over a period of some ten years.

The first method which is described is that for determining the amount of colouring matter (hæmoglobin) in a sample of blood. For this purpose two chief procedures have come into use clinically. The principle of the one is that of taking a standard solution of hæmoglobin of known dilution and diluting the sample of blood to be tested until its tint is similar to that of the standard (method of Hoppe-Seyler, modified by Gowers by the use of a picrocarmin gelatin, standardised to a known strength of hæmoglobin solution). The other proceeds on the principle of diluting the sample of blood to a constant extent and comparing it with glass tinted to resemble solutions of hæmoglobin of known degrees of dilution (method of Fleischl). In practice this method is the more simple and accurate, and has been adopted by Dr. Oliver, who has, however, for adequate reasons discarded the use of a coloured glass wedge which is the characteristic of Fleischl's hæmometer, and has adopted, instead, a series of coloured glass discs which represent gradations (percentages) in the amount of hæmoglobin of blood as compared with the normal. One of the most important reasons for this modification of the method is of great scientific interest; for it was found by Dr. Oliver, when making observations with Lovibond's tintometer on the mixture of colours required to reproduce exactly the tint of solutions of hæmoglobin of different strengths, that it is not possible to take a glass of a tint the same as that of a fairly strong solution of hæmoglobin and, merely by decreasing its thickness, to imitate the colour of a very weak solution, but that it is necessary, also, to alter the tone of colour with the change in strength of the solution, *e.g.* for comparison with weaker solutions of hæmoglobin it is necessary to add more yellow to the tint of the glass standards which are used for comparison with stronger solutions. The second method described is one for rapidly computing the number of coloured corpuscles in a given sample of blood. The older method depends upon the actual counting of the number in a measured quantity of blood diluted to a known amount with an isotonic solution of salts; indeed, all methods of computation must be standardised by this one. But such computation is laborious and takes some 15 minutes at the very least, whereas by the procedure devised by Dr. Oliver a satisfactory result can be obtained in less than 5 minutes. The method takes advantage of the fact that the coloured corpuscles of the blood impart opacity to any fluid in which they are suspended in sufficient number, and with normal blood taken as the standard a less or greater percentage of corpuscles than the normal can be at once arrived at with considerable accuracy by determining at what dilution the flame of a candle can be seen through the mixture. By the employment of this method Dr. Oliver has made many determinations of the percentage (as compared with normal) of corpuscles in blood taken under different conditions both in health and disease, the chief of these varying conditions being those relating to time of day, rest and exercise, digestion, temperature and altitude. It is known that the number of red corpuscles per cubic millimetre may rise from 4,500,000 at sea-level to 7,000,000 or 8,000,000 at elevations of from 6000 to 14,000 feet above sea-level. This has been determined by Viault on the Cordilleras and by Egger and others on the Alps, and is confirmed by the author, who finds that the increase is apparent within 24 hours and attains its maximum within the first week. It is, however, not as great as had been supposed; part of the former results depending upon an inaccuracy (at low barometric pressures) in the instrument usually employed for enumeration, an inaccuracy not shared by the cytometer employed in these investigations. The description of these two methods and their results occupies nearly one half of the book, the other half being taken up by a description of methods for investigating the condition of the blood-vessels.

Of these the first is one for determining the average blood-pressure in the arteries. It is based upon the ascertained fact that any instrument which is used to observe the arterial pulse by external application gives the largest indications of pressure variations when the force with which it is itself pressing upon the artery is equivalent to the average blood-pressure within the vessel. This principle has already been employed for gauging the blood-pressure in man by Mosso and others, but the instrument which has been contrived by Dr. Oliver for the purpose, and which he called a "hæmodynamometer," is both more sensitive and more easy of application than most others which have been devised, the pressure being applied to a spring through an india-rubber bag or pad filled with fluid, and the indications being directly read off upon a dial (as in Hill and Barnard's original sphygmoscope). An even more ingenious instrument is the "arteriometer," which directly and with great accuracy measures the calibre of an artery, such as the radial, through all the tissues which cover it. Dr. Oliver has, with the aid of these instruments, recorded a very large number of observations upon the effects upon blood-pressure and upon the arteries of varying physiological conditions such as posture, exercise, emotions, rest and sleep, fatigue, food and digestion, temperature and climate; for the details of these and for many other observations on the effects upon the circulatory system of baths, massage and various other forms of treatment the interested reader is referred to the account which the author has himself given. The book furnishes an excellent illustration of what can be done by the scientific physician for the advancement of physiological knowledge, and its perusal will repay, not only the clinician for whom it is primarily intended, but also the physiologist who desires to compare the results which he obtains by experiments upon animals with those which can be obtained by experiments upon man.

E. A. S.

A GERMAN NATURALIST IN THE WEST INDIES AND AMERICA.

Von den Antillen zum Fernen Westen; Reiseskizzen eines Naturforschers. By F. Doflein. Pp. iv + 180. Illustrated. (Jena: G. Fischer, 1900.) Price M. 6.50.

WHILE containing little or nothing in the way of absolute novelty, this narrative of the travels of a German naturalist in the West Indies, Mexico, California, and the far North-West of America is a pleasantly written and charmingly illustrated volume which can scarcely fail to interest and attract a large number of his fellow-countrymen. According to the author, German travellers but seldom visit the countries through which he passed, so that the greater part of what he has to tell will be new to the majority of his readers. With the exception of two, the originals of the photographic illustrations, which add so much to the attractiveness of the volume, were taken by the author himself; and the exquisite manner in which these photographs have been reproduced reflects the highest credit on the firm to whom the task was entrusted.

The first part of the book, which is divided into seven chapters, is devoted to the West Indies, where Martinique was the first island visited. Here the author was much interested in the botanical gardens, where he was struck by the richness of the vegetation, and especially by the luxuriance of the lianas. Several charming views in the island are given.

The author's next point was Barbadoes, where he left the great ocean steamer to take passage in a smaller vessel for a cruise among the lovely isles of the Lesser Antilles group. After devoting several chapters to his experiences among these, the narrator discusses in the sixth the racial problems presented by the West Indies, illustrating a few characteristic types. In Chapter vii. he treats of the fauna of the Lesser Antilles, dwelling on the close connection existing between the animals of that group and those of Venezuela, Colombia and Central America, and giving good pictures of a few of the more remarkable forms, among them the dreaded *fer-de-lance* snake. A section of this chapter describes in some detail the coast fauna of Martinique, a striking feature of this part being the photograph of a tropic-bird in flight.

The remaining nine chapters, forming the second half of the volume, describe the continental portion of the author's tour, and are at least as full of interest as their predecessors. In the first of these chapters (viii.) we have an instructive sketch of the ancient buildings and weapons of Mexico, which the author calls the Pompeii of America. In addition to a view of the celebrated temple of the sun and photographs of stone weapons, the author gives a plate of human and animal clay masks collected by himself at Teotihuacan. In Chapter ix. we have a description of a traverse of the great desert tract of Mexico, illustrated by an excellent photograph of giant cactuses; while, in striking contrast to this, the reader, in Chapter x., is introduced to the glories of a summer's day in California. Following the latter is a description of a Chinese settlement in the same country, where the photograph of "Chinatown" will not fail to impress the reader with the importance assumed by the Mongolian element in this part of America. Nor is zoology by any means neglected, Chapter xii. being devoted to an account of the Californian marine fauna, illustrated with a photograph of one of the remarkable Pacific hag-fishes of the genus Bdellostoma, and a second of the Californian medusa-starfish. Lovers of forest scenery will be enchanted with the beautiful photograph of a Sequoia-forest in California, which forms the most striking feature in the thirteeenth chapter; this chapter dealing, not only with the primeval forests of the district, but likewise with the timber-felling industry.

In his concluding chapter, Dr. Doflein presents his readers with a capital account of the Yellowstone Park and its animal wonders, illustrating his description with an excellent photograph of a family party of black bears in their native wilds. The photograph of bisons is, however, by no means so successful as it might be, being, for one thing, on much too small a scale. Still more unsatisfactory is the one on page 175 lettered "Die Amerikanische Gemse (Weibchen)," which is intended to portray the female of the prongbuck. If we are not mistaken, the animal in the foreground is a wapiti hind, while the one in the middle distance might be anything.

To any English reader desirous of keeping up his German by the perusal of a pleasantly written narrative of travel, Dr. Doflein's work may be commended; to his own countrymen it will commend itself. R. L.

A BIBLICAL ENCYCLOPÆDIA.

Encyclopaedia Biblica, Critical Dictionary of the Literary, Political and Religious History, the Archaeology, Geography and Natural History of the Bible. Edited by Prof. T. K. Cheyne and Dr. J. Sutherland Black. Vol. ii. E—K. (A. and C. Black, 1901.) Price 20*s*. net.

A WORK like this demands a critic whose forte is omniscience, for the articles are written by men who can speak as authorities, and necessarily enter into questions of theology, a province of human thought with which science is only indirectly concerned. This alone makes it difficult to give any notice of the book in a publication strictly scientific. To read through a volume of 1544 closely printed columns of small type would be a herculean task which we do not pretend to have attempted. We have not perused more than a few of the salient articles in the present volume, which, as it contains the letters from E to K, happens to include a large number of exceptional interest. If we remember that even the letter J covers names such as James, Jasher, Jeremiah, Jerusalem, Jesus, Job, John, Jordan, Joshua, Joseph, Judah and Judges we realise the significance of many articles. These seem to be summaries of everything important that has been written on the subject. Indeed, sometimes the variety is a little bewildering to the ordinary reader, who, however, cannot complain of a stinted choice, though the writers generally favour views distinctly progressive. One or two slips, notwithstanding the care with which, obviously, the work has been done, have caught our eye, such as the statement that the vicinity of Jerusalem consists of strata of the Eocene and *Chalk* formations—where Cretaceous should have been written, as the limestone is not the variety designated chalk; or the obvious clerical error that Esdraelon lies 250 feet *below* the sea-level, which would make it difficult for the river Kishon to reach the Mediterranean. But the topographical articles, which of course have to be largely dealt with from the historical point of view, are generally excellent. For instance, the article "Geography" gives a most interesting account of what was known about that subject by the Old Testament writers. Formerly, no doubt, when the relations of theology and science were ill-understood, questions of Hebrew cosmogony and ethnology were more important than they now are; still there is an antiquarian interest, when the date of a document can be approximately determined, to see how much or how little the Hebrews had ascertained about the rest of the world. Evidently the knowledge of the Old Testament writers hardly extended eastward beyond Persia, or northward so far as the Caucasus, or southward beyond Ethiopia on the African continent, or westward of Greece, excepting Tartessus in Spain or possibly either Sicily or Carthage. If they had any notions of regions lying beyond those limits, such as India or China, these must have been of the vaguest, unless we locate Ophir in Mashonaland, to which identification, however, as we infer from the article on gold, the editor does not incline. The books of the Old Testament cover a long time, and knowledge grew; but we may safely assume that the writer of the ethnographical notices in Genesis x., whatever be their date, either did not know of, or deliberately excluded, the Black and the Yellow races. Probably, indeed, until about the tenth century before our era, the Hebrews had only a very limited knowledge of geography. The article on Egypt is full of information and has been brought down as nearly as possible to date. It is accompanied by three very useful little maps; one, a physical map of the Nile valley, north of Khartoum, another, on a smaller scale, of the Nile and the Euphrates, and a third showing the broader features of the geology. This brings out very clearly the close connection between the Sinaitic peninsula and the mountain region between the river and the Red Sea, and contains much information in a very small space.

A comparison of the historical part of this article with that in Smith's "Dictionary of the Bible," published in 1860, indicates, better than anything, how enormously our knowledge has been increased during recent years. The same is true in regard to the articles on the topography of Jerusalem. No doubt the one in the older work was below the general level, for the editor, owing to some strange infatuation, had accepted as established facts the absurd fancies of the late Mr. James Fergusson. These are properly ignored in the work before us, which treats this difficult and thorny subject in a fair and scholarly fashion. The author may sometimes incline to one view, the reader to another, but evidence is not perverted as it was in the older work. Personally, for instance, we do not believe the Ophel Hill to have been the site of the City of David. The passages supposed to be favourable to this identification are not, in our opinion, of much weight, and the distance of Jebus from any known spring is a difficulty which attaches to many hill forts. Some in our own country could not have endured a close siege for a few days without storage of water, and cisterns were familiar things at Jerusalem.

The western hill, like another Gergovia, is a natural site for a hill fort, while the descending ridge of Ophel, so far as we can infer from our studies of such structures, is exactly the position which their builders would have avoided. Such articles as "Gospels" and "Jesus" introduce us to questions of a character and a theological import which we must not discuss in these columns. Suffice it to say that, while indicating a certain amount of reaction from the extreme vagaries of representatives of the so-called "higher criticism," they express, as a rule, eminently "progressive" views. Some, indeed, are so very advanced that they could not, so far as we can see, be covered by the most liberal interpretation of the Nicene creed. Persons, however, who view with anxiety these removals of ancient landmarks may comfort themselves by observing how many idols of the cave have been set up by one confident discoverer only to be trampled under foot by the next comer. Indeed, on reading some of these efforts of the higher criticism we cannot help being reminded of the famous Historic Doubts, and think that by using similar methods we could prove William the Conqueror to be a person almost mythical and the Battle of Hastings mainly a legend. T. G. B.

OUR BOOK SHELF.

Plato's Staat. F. Schleiermacher. Zweite Auflage. C. Th. Siegert. (1901.) Mk. 3.

John Locke's Versuch über den Menschlichen Verstand. Zweiter Band. Zweite Auflage. C. Th. Siegert. (1901.) Mk. 3.

Berkeley's Abhandlung über die Prinzipien der Menschlichen Erkenntnis. Dr. F. Ueberweg. Dritte Auflage. (1900.) Mk. 2.

Berkeley's Drei Dialoge zwischen Hylas und Philonous. Dr. R. Richter. (Leipzig: Dürr'schen Buchhandlung, 1901.) Mk. 2.

THERE is in Germany a widespread appetite for metaphysics. Earlier there than elsewhere scholars and philosophers of an order not far removed from the highest came to recognise that work bestowed on the translation and elucidation of foreign masterpieces in philosophy was the best of trainings in exact thinking and expression. The zeal of von Kirchmann for his educational ideal was untiring, and his industry was appalling. In the result, the *Philosophische Bibliothek* has succeeded in combining low cost and high achievement. It is the more to be regretted that its volumes so often come to pieces in the hand.

Schleiermacher's translation of "Plato's Republic," with von Kirchmann's sporadic notes, "needs no bush." It will not, of course, be much used in England after the labours of Davies and Vaughan and Dr. Bosanquet. It has undergone some revision, but still scorns Greek accents, while its use of breathings is haphazard. Similarly, von Kirchmann's translation of "Locke's Essay" has undergone revision before reissue. Something of the effect of Locke's style vanishes in the translation, but the substance is there. It is only the separate volume of notes which is likely to interest the English public, and that not greatly. Ueberweg's excellent version of the masterwork of Berkeley's earlier idealism has passed into a third edition, advisedly without revision. Its incisive notes possess some value even for those who have studied their Berkeley with the aids supplied by Prof. Campbell Fraser. It has a worthy successor in Dr. Raoul Richter's translation of "Berkeley's Three Dialogues between Hylas and Philonous." If we have not been singularly unfortunate—or fortunate—in our sampling, Dr. Richter has succeeded as well as the translator of Berkeley could hope to succeed. He adds a straightforward introduction and some luminous notes chiefly on the usage of technical terms. The new series is, to our thinking, superior in form, printing and, above all, in stitching, to the old. The student, for whom the reading of Kant or Hegel in the original is only a hope of the distant future, might be worse advised than to take Dr. Richter's version of the dialogues and ground himself in German philosophical terminology by reading it along with the brilliant original. An English translation of a German "minor masterpiece" at once as excellent as this and as cheap is still to seek.

H. W. B.

The Fishes of North and Middle America; a Descriptive Catalogue of the Species of Fish-like Vertebrates, found in the Waters of North America, North of the Isthmus of Panama. By David Starr Jordan and Barton Warren Evermann. Part iv. Pp. ci + 3137–3313; plates I–CCCXCII. (Washington: U. S. National Museum, 1900.)

THE present part concludes this important work, of which we have given a full notice in vol. lxi of NATURE, p. 362. It commences with a systematic arrangement of the fishes described, which serves not only as a table of contents for all the four parts, but also as an exhibition of the views of the authors as to the genetic relations of American fishes. From it it will be seen that the fish-fauna of North and Middle America, as now understood and as stated by the authors, embraces 3 classes, 30 orders, 225 families, 1113 genera, 325 subgenera, 3263 species and 133 subspecies. "Additional Addenda" follow and occupy some 60 pages; they comprise a number of new genera and species described since the publication of part iii., the majority being the result of investigations made by Dr. Jordan in Mexico, and by Dr. Evermann in Porto Rico. Other additions or corrections regarding nomenclature, relations and distribution of previously known species, are duly attended to.

The bulk of the volume is devoted to the illustrations. In this series are represented about 958 types of fishes, thus, so far as numbers are concerned, surpassing even Cuvier and Valenciennes' "Histoire naturelle des Poissons," in which only about 700 species are figured. With few exceptions, the figures are original, and were drawn for the present work from specimens preserved in American collections, and by means of photography reproduced to a uniform size, the width of an octavo page. As the work has been published by the Smithsonian Institution with the view of bringing it within the reach of the people, no highly artistic and, therefore, expensive finish of the illustrations has been attempted; but they have not lost in accuracy thereby, and will fully answer the purpose of assisting the student of ichthyology in his initial studies, or the layman who seeks for occasional information. They show well the general appearance of the fish, the structure of fins and the arrangement of scales; but scarcely any additional details are given to illustrate the characters on which the numerous genera and species distinguished or adopted by the authors are based.

The illustrations are preceded by an explanatory list, in which the names of the artists, the numbers of the original specimens in the United States National Museum, or other sources whence the drawings were derived, are carefully noted. In fact, no pains have been spared by the authors to render their work instructive and handy for reference and ready use.

Already in our first notice we have testified to the high merits of the work; it renders the rich American fish-fauna more accessible than ever before to scientific ichthyologists throughout the world, and cannot fail to give a powerful impetus to the study of fishes in the authors' own country. A. G.

Die wissenschaftlichen Grundlagen der analytischen Chemie elementar dargestellt. Von W. Ostwald. Dritte Auflage. Pp. xi+221. (Leipzig: Engelmann, 1901.) Price M. 7.

THE services that Prof. Ostwald has rendered to physical science during the last quarter of a century are so numerous and so valuable that his writings cannot fail to exert considerable influence. In working out and extending the theories of van 't Hoff and Arrhenius he played a leading part in laying the foundations of physical chemistry; and in applying these principles to the consideration of the problems of analytical chemistry, he has effected a complete revolution in the methods of approaching that subject. In 1894 he published the first edition of the "Wissenschaftliche Grundlagen," and thus furnished us with scientific explanations of much that up till that time had been little more than mere empiricism; analytical processes were interpreted by him in the light of the theory of solutions and the ionic hypothesis, and thus new life was infused into a branch of science that had become almost moribund.

It is gratifying to think that Prof. Ostwald's efforts have been appreciated; and the fact that a third edition of this striking work has been called for is sufficient evidence of its success. The new ideas are beginning to take a firm root, and are already finding their way into the latest text-books on the subject.

It is to be hoped that teachers of practical chemistry will study the pages of this last edition of the "Grundlagen der analytischen Chemie," and arrange their methods of instruction on the new lines it suggests. With this end in view Prof. Ostwald has added a chapter containing descriptions of a number of experiments illustrating some of the more important principles on which analytical chemistry is based.

In conclusion, we would draw attention to the closing words in which the author advocates the use of as simple apparatus as possible, that the attention of the student may be concentrated on the chief features of the experiment. Coming from so brilliant an experimenter and so popular a teacher, the advice is worthy of special emphasis.

An Introduction to Modern Scientific Chemistry. By Dr. Lassar-Cohn. Translated by M. M. Pattison Muir, M.A. Pp. viii + 348. (London: H. Grevel and Co.)

THE German original of this book has already been noticed in these columns (vol. lxi. p. 51, 1899). It has been translated into smooth English by Mr. Pattison Muir, and it may be cordially recommended as a clear exposition of the leading facts and principles of chemistry, well adapted to the class of readers for whom it was written, namely, University extension students and general readers. It must be borne in mind that the book is not intended for those who are able to study chemistry with their own *hands.* The fifty-eight illustrations in the book are its worst feature, but they are by the author, and no doubt the translator had no choice but to reproduce them. A. S.

First Aid to the Injured. By H. Drinkwater. Pp. 104. (London: J. M. Dent and Co.; no date.) Price, 1*s.* net.

THE number and excellency of the illustrations are special features of this little book, and increase its interest and clearness, doing away also with the need of lengthy explanations. The proportion between the theoretical and practical parts is well maintained. The anatomical details are not by any means unduly prominent, but are only introduced in so far as they are necessary to enable the practical directions to be intelligently followed. The book can be strongly recommended as a clear and trustworthy instruction in "first aid."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Solution of Cubic and Biquadratic Equations.

THE historical note in your last number by Sig. Vacca regarding the graphical solution of a cubic, given by Mr. T. Hayashi, reminds me that I had intended, when Mr. G. B. Matthews published his suggestion for the graphical solution of a biquadratic by means of two parabolas (NATURE, Nov. 16, 1899), to point out that he too had been anticipated, as will be seen by referring to a paper by Mr. R. E. Allardice in the *Proceedings* of the Edinburgh Mathematical Society (April 7, 1890), where it is shown that, with the exception of the case where the roots of the biquadratic are equal in pairs, the real roots of the general biquadratic can be found graphically by means of two equal parabolas having their axes at right angles, the one fixed and the other movable; and also that every cubic can be reduced to the form $y^3 \pm y + r = 0$; and then solved graphically by means of the fixed curve $y = x^3$ and the movable straight line $x \pm y = r$.

I may take this opportunity of calling the attention of elementary teachers to the fact, also dwelt upon in Mr. Allardice's paper, that the most convenient method of discussing the algebraic solution of the general biquadratic, and of testing whether any particular biquadratic is soluble by means of quadratics or not, depends on the familiar theorem that $ax^2 + 2hxy + by^2 + 2gx + 2fy + c$ is decomposable into linear factors if $abc + 2fgh - af^2 - bg^2 - ch^2 = 0$, and not unless. Along with the biquadratic $x^4 + px^3 + qx^2 + rx + s = 0$ (1) consider the equation $x^2 - y = 0$ (2). By interequational transformation it is obvious that the system (1), (2) is equivalent to the system composed of (2) and $qx^2 + pxy + y^2 + rx + s = 0$ (3). Again, the system (2), (3) is equivalent to the system composed of (2) and $(q - \lambda)x^2 + pxy + y^2 + rx + \lambda y + s = 0$ (4), where λ is a constant at our disposal. If λ be so chosen that the left hand side of (4) breaks up into linear factors; that is, if λ be a root of the cubic

$$\lambda^3 - q\lambda^2 + (pr - 4s)\lambda + 4qs - r^2 - p^2 s = 0 \qquad (5),$$

then the system (2), (4) will be equivalent to two systems $y + \mu x + \nu = 0$, $y = x^2$, and $y + \rho x + \sigma = 0$, $y = x^2$. In other words, the four roots of (1) are the roots of the two quadratics $x^2 + \mu x + \nu = 0$, $x^2 + \rho x + \sigma = 0$.

The cubic (5) is not in general soluble by means of quadratics without the adjunction of a cube root: hence the solution of a biquadratic in general depends on the solution of a cubic and two quadratics.

The necessary and sufficient condition that the cubic be soluble by means of quadratics is that it have a commensurable root, which, if it exist, can be readily found by finding an integral root of another cubic of the form $x^3 + ax^2 + bx + c$, where a, b, c are all integral. The determination of μ, ν, ρ, σ then requires, in addition to rational operations with p, q, r, s, λ, merely the extraction of a square root.

To the tyro who is familiar with the elements of the coordinate geometry of the conic sections the rationale of the above process can be made evident by the consideration of the two line-pairs which contain the four points of intersection of two conics. It may be noted that, instead of the parabola $y = x^2$, we may use the rectangular hyperbola $xy = 1$, the only difference being that we are led to a different cubic resolvent.

Considering the space usually given in English text-books of algebra to the discussion of equations which are soluble by means of quadratics, it is strange that few, if any, of their authors emphasise the fundamental fact that the reduction of a biquadratic which is soluble by means of quadratics can be effected by finding the rational root of a cubic equation. I fear that I too must plead guilty to this omission, which among other things I propose to make good in the next edition of vol. i. of my "Algebra." G. CHRYSTAL.

Edinburgh, April 26.

Electro-Chemistry.

ALLOW me to point out an omission unnoticed by your reviewer of Mr. Bertram Blount's book on practical electro-chemistry (p. 582). Mr. Blount refers to the electrolysis of gold ore as a failure (Haycraft's method).

The omission is probably due to the fact that the process in question (Riecken's) has not been worked on a large scale except during the last three or four months, though the patent is three years old. Its efficacy depends essentially on securing a clean mercury kathode in the form of a thin stream of mercury flowing over a nearly vertical copper plate.

The liquid containing the pulverised ore is a continually agitated solution of cyanide and the anode is of iron, as the electro-motive force, one and a half volts, liberates nothing more corrosive than cyanogen. The particles of gold are doubtless cleansed of the obstructing sulphide and tellurous films by the convection currents of ionised cyanogen and also, in a more direct way, by the current as it passes through each particle, making in effect one side of it a kathode and the other an anode, just as is seen if we suspend a piece of metal in an electrolyte between the electrodes and unconnected with either.

This simple invention may revolutionise the treatment of refractory ores, yet apparently the inventor could get no hearing for three years till, at his own cost, he erected apparatus on a working scale in West Australia. The facts are valuable as showing how great an interval separates German intelligence from British engineering practice.

Intelligence of any kind, foreign or native, must indeed have been wanting when huge works, regardless of cost, were erected in presence of the published electrolytic method which could have been effectually tested in a single vat.

JOHN HILL TWIGG.

IF, as your correspondent, Mr. Twigg, says, Riecken's electrolytic process has only been worked on a large scale during the last three or four months, it is not unnatural that Mr. Blount has omitted to describe it. In most cases Mr. Blount has endeavoured to describe processes which are of proved utility, and therefore it was hardly necessary to draw attention to the omission. Further, the number of patents on the subject of electrolytic gold refining is very large, so that it would be manifestly impossible to describe them all. Riecken's process is a very neat one, and should any of the readers of NATURE be interested in the subject, an excellent description is to be found in the "Jahrbuch der Electrochemie" (vol. v. p. 380).

F. MOLLWO PERKIN.

Unusual Agitation of the Sea.

ON Wednesday, April 24, on going to the edge of the cliff above Alum Chine, Bournemouth, at 7.50 a.m., I was struck by the appearance of a succession of waves, resembling a slight ground swell, reaching the shore from an otherwise calm sea, there being no wind. The character of the waves was rather peculiar, and I then saw that every now and then, at intervals of about two or three minutes, much larger waves came in, and instead of breaking abruptly, extended quietly up the sandy beach to a greater height than was expected from their apparent elevation. I mentioned the phenomenon on reaching the house, and on the suggestion that the waves were the result of a distant storm, could not see that they might be so accounted for. Between 12 and 1 p.m. I again watched the undulations, and roughly measured the length on the beach by which the larger waves extended further than those of ordinary size. This was about 22 feet. The larger waves were less frequent than in the morning. Later in the afternoon, soon after 3 o'clock, some of my family were caught by the exceptionally large undulations, which rose surprisingly high upon the slightly sloping sand.

I have not heard whether any remarkable disturbance has been recorded by the seismometer, but I see in the *Daily Mail* and *Daily Express* of April 25 and 26 telegraphic reports of earthquakes in Italy, Portugal and Guernsey on April 24.

ROLLO RUSSELL.

RECENT DEVELOPMENTS IN ELECTRIC SIGNALLING.

IT is thirteen years since Hertz carried out the brilliant series of experiments which, apart from their great theoretical value, had the important effect of laying the foundation of modern systems of wireless telegraphy. Three years later we find the *Electrician* making the suggestion that the discoveries of Hertz might be utilised for signalling to lightships, and five years later still, in 1896, Signor Marconi brought over to England the first practical wireless telegraphic apparatus and awakened public interest by the remarkably successful experiments which he carried out on Salisbury Plain and across the Bristol Channel. For a time the technical and lay Press was full of wireless telegraphy; great prospects were predicted for it; communication with lightships and lighthouses was the least of the feats it would accomplish; telegraphy at sea was to become as common as on land; some even went so far as to say that wires and cables of all sorts for telegraphic purposes were to become a thing of the past. But these revolutionary changes, if they are ever to be made, did not come with the rapidity which many apparently expected. It was soon recognised that we needed to know a great deal more about the subject before Hertz waves were to be even a trustworthy servant to the telegraphist, and even now we can scarcely call wireless telegraphy much more than experiment. But we have now more definite grounds for feeling sure of its ultimate success, and we can predict for it a useful future with much more surety and reason than was done in the first outburst of enthusiasm that followed Mr. Marconi's experiments.

The patient and persevering experimenting of the past five years has led to the gradual surmounting of many of the difficulties which at first beset wireless telegraphy, and Mr. Marconi, Prof. Slaby and the other pioneers who have thrown themselves with vigour into its development have met with a success which, if not complete, is yet very promising. It is not the greatly increased distance over which it has become possible to signal, an increase from a few miles in 1896 to more than 200 in 1901, that marks the most important development that has occurred. The greatest achievement is the successful solution of the problem of tuning. It was early seen that before wireless telegraphy could have at all an extended utility it would be necessary to find some means of confining each message to its correct destination and of preventing each receiving apparatus from responding to Hertz waves sent out from any transmitter in its neighbourhood. It seems that now almost all experimenters have overcome this difficulty, at any rate to a certain extent.

The improvement in distance over which it is possible to signal has been very marked. The empirical law put forward by Mr. Marconi that, other things being equal, the distance over which signalling would be possible was proportional to the product of the heights of the masts at the two ends seems to be fairly well established as a working rule. But the improvements in transmitting and receiving apparatus have been so great that it is now possible to signal over much greater distances with the same heights of masts than was the case in 1898. For example, in 1898 Mr. Marconi was only able to cover 15 miles with vertical wires 120 ft. high, whereas to-day, according to the recent announcement made by Prof. Fleming, a distance of 200 miles from the Lizard to St. Catherine's, Isle of Wight, has been signalled over with masts only 160 ft. high. Mr. Marconi certainly holds the record for long distance work. The example just quoted refers to signalling across sea; across land such great distances have not been attained, but here again we think the credit of having signalled over the greatest distance must be given to Mr. Marconi, who established in 1899 communication between Dovercourt and Chelmsford, a distance of more than 40 miles.

These long distances have been attained by Mr. Marconi partly by the use of a specially constructed transformer in the receiving circuit. Instead of connecting the vertical receiving wire in series with the coherer it is connected in series with the primary of this transformer, the secondary of which is in series with a condenser and the coherer. By this means the voltage of the received oscillations is increased, and the resistance of the coherer more easily broken down. A somewhat analogous arrangement is used by Prof. Braun, to whose work allusion has already been made in NATURE,[1] in the transmitting circuit, the oscillations in the vertical wire being set up by induction and not by directly including the spark gap between the vertical wire and earth. The results that have been obtained by Prof. Braun are not, however, nearly so good as Mr. Marconi's latest work.

So far as tuning is concerned, Mr. Marconi appears to have successfully got over this difficulty. Prof. Fleming, in the lecture above referred to, stated that the communication between the Lizard and St. Catherine's was multiplex, it being possible to receive two or more messages at once at each place. Mr. Marconi himself, in an interview with an American contemporary, said that with his improved apparatus he could send or receive 2, 10 or 50 messages at the same time, without any interference whatever. Particulars as to the method have not, however, been published as yet, but it is to be hoped that the details of the system will be explained by Mr. Marconi at his forthcoming lecture at the Society of Arts.

In Germany the subject of wireless telegraphy has been tackled principally by Prof. Slaby and Count Arco, who took up the subject in order to find a system for the German Navy, to replace that of Mr. Marconi, the Marconi Company charging, it was said, prices prohibitive to any but the English Navy. Although the results, so far as distance is concerned, which Prof. Slaby has obtained are not very great, the system that he has developed is one of great interest and seems to be founded on sound scientific principles. Prof. Slaby has aimed throughout at getting rid of interference by producing only oscillations of a definite wave-length and tuning the receiver only to respond to these particular waves. In order to produce the oscillations, the transmitting circuit is arranged as shown in Fig. 1. An earthed loop of wire, ACDE, is used, instead of the single insulated vertical wire usually employed, in one arm of the loop there being a spark gap, AB, and a condenser, K. The ends C and D of the vertical wires are joined by a coil of wire as shown. In charging the condenser the whole loop is used, but in discharging it is only the arm ABC which is utilised, the coil of wire CD preventing the oscillations passing into the remainder of the circuit. Upon the length of the wire KC and the capacity of the condenser K the wave-length of the oscillations depends, and from their known values it can be calculated.

Theoretical considerations showed Prof. Slaby that the free ends of both the transmitting and receiving wires, *i.e.* the ends C and E (Fig. 2), are potential loops, and that the earthed ends B and D are potential nodes. If, now, to the receiving wire DE a second wire, DF, equal in length to CD, is connected, there will be a potential loop at F. At E and F, therefore, the potential will vary over a much greater range than at D. If at F a further length of wire, J, is attached, such that its length is half a wave-length, then there will be established between F and the free end, G, of the coil J a difference of phase of 180°. At both points there will be potential loops, but when the potential F has a maximum value in one direction that at G will have a maximum value in the opposite direction, and the potential difference between F and G will be double that between F and earth. By connecting the coherer between F and G it can thus be made to respond to received oscillations much feebler than those which would be required to work it if it were connected, as is usual, between D and earth. As an additional advantage, the earth connection at D can be removed, and the whole receiving apparatus thus rendered earth free.

Experiments have been made from time to time to devise a suitable repeater for use with wireless telegraphy, and the results of some work which has been done by M. Guarini on this subject were recently published in the *Electrician*.[1] M. Guarini established stations at Brussels, Malines and Antwerp; messages were successfully transmitted between Brussels and Malines and also between Malines and Antwerp, and a repeater was then set up at Malines with the object of automatically transmitting the messages received from Antwerp to Brussels. The experiments were not, however, very successful, as the repeater did not always transmit the signals, and it was found, consequently, impossible to send any actual messages. A trustworthy repeater for wireless telegraphy would be very useful, but it is scarcely necessary to point out that it must be absolutely trustworthy, as if a man has to be on the spot to keep it up to its work he may as well be employed in retransmitting the messages.

In the meantime the wire-using telegraphists have been by no means panic stricken by the achievements of their wireless competitors, and some very notable developments have taken place during the past few years. We can only describe here a few of these; those who are more deeply interested in the subject may be referred to Mr. Gavey's paper on telegraphs and telephones at the Paris Exhibition, read recently before the Institution of Electrical Engineers,[2] in which will be found descriptions of all the more important improvements effected in the last few years. One of the most remarkable is the Pollak-Virag high-speed telegraphic system. This system attracted considerable attention both in the technical and lay Press when it was first brought forward, towards the end of 1899, on account of the extremely high speed of signalling which it was said to be possible to attain by its use. It was reported that in trials in America a speed of 60,000 words an hour had been maintained over a line which was over 1000 miles in length, and that a speed as high as 100,000 words an hour had been attained. This is a very great improvement on the 400 or 500 words a minute possible with the Wheatstone automatic or Delaney multiplex systems, which are those commonly in use in this country. These remarkable results had been achieved by the use of a telephone diaphragm as the receiving instrument, the diaphragm being deflected by the currents received through the telegraph line and a deflection in one direction corresponding to a dash and in the opposite direction to a dot. The movements of the diaphragm were recorded photographically, a small mirror being attached to the diaphragm and a ray of light being reflected from this on to a revolving drum covered with a roll of sensitised paper. The record had, of course, to be subsequently developed in the ordinary manner.

Since its first introduction the system has undergone considerable development, a very ingenious modification

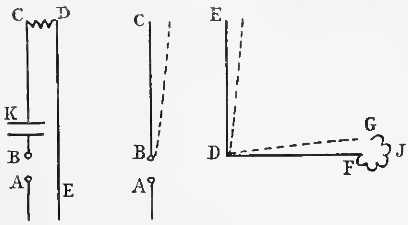


FIG. 1. FIG. 2.

[1] NATURE, 1901, vol. lxiii. pp. 403 and 474.

[1] The *Electrician*, March 22, 1901, vol. xlvi. p. 819.
[2] *Journal* of the Institution of Electrical Engineers, 1901, vol. xxx. p. 73.

having been introduced by means of which the recorded message is written in ordinary Latin characters and can consequently be read by any one. In order to do this it is necessary to give the mirror on the receiving instrument a horizontal as well as a vertical motion, and for this purpose two circuits are needed and two telephone diaphragms, one giving the mirror vertical movements and the other horizontal. A single metallic loop is employed, one telephone being put in the loop and the other between the loop and earth. Horizontal movements of the mirror, to right and to left, are produced by currents passing round the loop in one direction or the other respectively, and vertical movements by currents passing from the loop to earth; in this second case an upward movement is produced by a current in one direction and a downward movement by a current in the opposite direction, and also a downward movement of double the distance by a current at double the normal voltage.

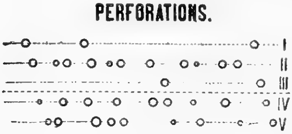


FIG. 3.

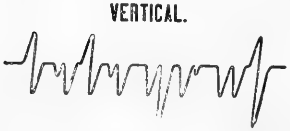


FIG. 4.

FIG. 5.

FIG. 6

The line currents are sent by means of perforated strips of paper much in the same way as in the Wheatstone transmitter, but five strips are used, three to give the vertical components and two for the horizontal. These strips are shown in Fig. 3; the rows marked i, ii and iii give the vertical components, the first row giving the tall letters and the third the deflections of double amplitude for the letters with tails; rows iv and v give the horizontal components. Deflections of a fraction of the normal amplitude are given by contacts lasting a shorter time by means of the small perforations as seen in rows ii, iv and v. The perforations are so arranged that the combination of the vertical and horizontal movements of the mirror (as seen in Figs. 4 and 5 respectively) gives the Latin characters (Fig. 6), and all the perforations for one letter are punched at the same time by means of a special machine of the typewriting kind. To obviate the difficulty of having to use a rapidly moving narrow strip of sensitised paper to receive the photographic record, as in a tape machine, a very neat device is employed. The source of light is the filament of an incandescent lamp, which is surrounded by an opaque cylinder in which a helical slit is cut. This cylinder is revolved, and as it turns the part of the filament acting as a source of light moves from left to right as the slit uncovers in succession the various portions of the filament; at the same time, the spot of light reflected on to the recording paper, which is a broad band of sensitised paper, will also move from left to right, thus writing a complete line on the paper; at the end of a complete revolution the spot will return again to the left-hand side of the paper band and will proceed to write a new line, this new line being brought under the other by a movement imparted to the band of paper. The message is thus directly obtained as an ordinary written message in lines one below the other, and the system has thus the great advantage over all Morse methods that the message has not got to be deciphered and transcribed by the receiving telegraphist. With this apparatus it is said that a speed of 1000 words a minute can be obtained.

The Pollak-Virag system, although in its most recent form it gives a record in ordinary handwriting characters, must not be confused with those systems designed to transmit the actual handwriting or drawing of the signaller. Several instruments, under the name telautographs, have from time to time been devised for this purpose, and the late Prof. Elisha Gray was, we believe, engaged on the perfecting of an invention of a telautograph at the time of his death. The attempts at solving the problem, which is, it must be confessed, a very fascinating one even though the very extensive utility of such an instrument may be questioned, have not, so far, proved very successful. Last year, however, there appeared in the technical Press descriptions of a telautograph which is the invention of Mr. Foster Ritchie, and which seems to have got over the difficulties in a very practical manner. In the Ritchie telautograph the message is written with an ordinary pencil; by means of levers attached to this pencil its movements are made to regulate the currents sent through the transmitting lines, and these currents in their turn regulate the motion of a pen at the receiving end. By an ingenious arrangement the receiving pen only makes marks on the paper when the transmitting pencil is pressed down on the writing table. The receiving pen exactly reproduces the characters written at the transmitting end, which can be written at the ordinary speed of handwriting. We hope on a later occasion to give a more detailed description of the apparatus.

We may finally describe an invention which has aroused considerable interest amongst our American cousins, namely, Dr. Pupin's system of long distance and oceanic telephony. Dr. Pupin has, we understand, disposed of his American patent rights to the American Telephone and Telegraph Company for a very large sum of money, which shows that this company have great confidence in the invention. The difficulty of carrying out successful telephony over a great length of line arises out of the fact that the line possesses both resistance and capacity; this is especially the case with submarine cables in which the capacity is large. These properties produce both attenuation and distortion of the transmitted signals, the arrival current being both very much weaker and different in character to the current sent into the cable at the transmitting end. The alteration in character is due to the fact that the more rapidly varying currents are more easily attenuated; if a varying current be sent into the cable by speaking into a telephone at the transmitting end this may be analysed, just as the sound to which it corresponds may be analysed, into a fundamental vibration and a number of higher harmonics; the higher harmonics will, after travelling along the cable to a certain distance, become so attenuated that they will be incapable of producing any effect on a receiving telephone, so that such an instrument, if placed at this point, will only be actuated by the fundamental lower harmonics, and the sound it gives out will, in consequence, be different in character from the sound originally made at the transmitting end. The effect will show itself, therefore, in defective articulation, or distortion of the sounds arising out of the distortion of the telephone currents.

It has been shown by Mr. Oliver Heaviside that there are ways in which this distortion may be prevented and a "distortionless circuit" constructed. Without entering too deeply into the subject we may point out briefly the methods by which this may be effected. Since the cable possesses capacity, the first effect of sending current into it is to charge it, and no signal can be received at the far end until the cable is partly charged, and no further signal until the charge has had time to get out. Now if the insulation resistance of the cable be diminished, the charges will more readily leak out and thus it would be possible to expedite signalling ; but at the same time the attenuation is increased, for more of the current will leak out of the cable ; the remedy is, therefore, only a partial one, for though the speed of signalling may be increased, so much current will leak out on the way that the amount arriving at the far end may be too small to work the receiving instruments. Instead of simply diminishing the insulation resistance or of distributing artificial non-inductive leaks along the cable, inductive leaks may be placed at definite points along the cable ; this method was proposed by Prof. S. P. Thompson in a paper read at the International Congress at Chicago in 1893.[1] A diagram of the cable construction suggested by Prof. Thompson is shown in Fig. 7 ; the capacity is represented as though it were not evenly distributed but

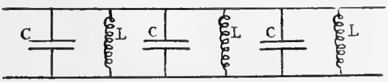


FIG. 7.

consisted of a number of condensers, C,C, connected as shunts to the cable ; the inductive leaks are represented by the coils L,L. The capacity and self-induction are therefore combined in parallel, and it is well known that they can be combined in this way so as to behave, for a definite frequency, exactly as an ohmic resistance. The capacity of a submarine cable may be partially neutralised in this way, but the remedy is only a partial one for three reasons. Firstly, the inductive leaks, to correctly neutralise the capacity, should, like the capacity itself, be evenly distributed along the cable and not distributed in jerks ; secondly, the correction will only be exact for a particular frequency ; lastly, the leakage is increased and the same defect consequently occurs as in the case considered above in which the distortion was corrected by diminishing the insulation resistance. Theoretically, therefore, the system proposed by Prof. Thompson does not offer a perfect solution or give a truly distortionless circuit ; but it would greatly diminish the distortion, though at the same time increasing the attenuation, and might therefore give a practical means of increasing the speed of signalling or even obtaining telephonic communication over the cable.

As Mr. Heaviside has shown, the only true way of obtaining a distortionless circuit—of obtaining *the* distortionless circuit, as he calls it—is to balance the effect of capacity by self-induction *distributed along* the cable in series with it and not as a leak to it. The four quantities which control the propagation of disturbances or signals along the line are its resistance, R, its external conductance, or conductivity of the insulation, K, its self-induction, L, and its capacity or "permittance," S, and the signals will be propagated without distortion if $L/R = S/K$. The equality of these two ratios may be obtained by altering any of the four variables, but practically we may consider R and S as fixed. In ordinary cables the value of the ratio L/R is very small, and that of S/K comparatively large. In order to make the two equal we may increase K, that is to say diminish the insulation resistance, but this, as we have seen, leads to excessive leakage and is not, therefore, desirable. The method suggested by Prof. Thompson amounts practically to converting the capacity, S, partly or wholly into insulation conductivity, K, and thus diminishing S/K until it is as small as L/R. The self-induction coils added in this system must not be confounded with the self-induction of the cable L, for they are added as shunts to the cable. The ratio L/R may also be made equal to S/K by adding self-induction coils in series with the cable, thus increasing the value of L ; this is the solution adopted by Dr. Pupin. Here again the ideal solution is only obtained when the self-induction is evenly distributed, but a practical solution can be obtained by placing coils at intervals along the cable.

Dr. Pupin, besides repeating a good deal of Mr. Heaviside's theoretical investigations, worked out the necessary values of the self-induction of the coils and the maximum distance apart at which they can be placed in order to imitate sufficiently well an evenly distributed self-induction. He then proceeded to build some coils and to experiment with them on an artificial cable. The results of some of these experiments are interesting, as they point to the great improvement the addition of the

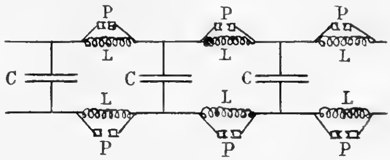


FIG. 8.

inductance produced. An artificial cable was built up with condensers in the usual way in 250 sections, each section representing a mile of cable ; between each section were placed induction coils which could be short-circuited by plugs. A diagram of this cable is given in Fig. 8 ; as before, the capacity is represented as if it consisted of condensers, C,C ; the induction coils are shown at L,L ; these coils are short-circuited by inserting the plugs at the contacts P,P. When all the coils were in circuit telephonic communication could be carried on with perfect ease over the whole length, 250 miles, of the cable ; when, however, the coils were short-circuited conversation was good up to 50 miles only, fair up to 75, impracticable at 100 and impossible beyond 112. It must be remembered in considering these results that the cable was an artificial one and that possibilities of error are consequently great, so that the results must not be transferred with too much confidence to the case of an actual cable.

Apart from this, however, the results are extremely good, and Dr. Pupin is to be congratulated on having obtained experimentally a practically distortionless circuit. It is perfectly true, no doubt, that Mr. Heaviside had obtained the solution already theoretically; but the engineers generally require to have their attention attracted by actual experiment and are not too prone to make changes on a theoretical basis only, however sound. Whether a cable can be commercially constructed on the lines of Dr. Pupin's artificial cable is a question for the practicians ; we have no doubt that, now its advantages have been demonstrated, they will be able to find a way. The enormous advantage of Transatlantic telephony can never

[1] See the *Electrician*, August 1893, p. 439.

for a moment be questioned; it means much more than that we shall be able to telephone to America; it means that we shall be able to telegraph at the speed of the automatic transmitter. The present speed of Transatlantic telegraphy is something like 20 words a minute, and there are 12 duplexed cables having, therefore, a carrying capacity of about 500 words a minute. A single distortionless cable, built on Dr. Pupin's plan and working with an automatic transmitter, would have, therefore, a carrying capacity equal to that of all the existing cables.

INDIGO AND SUGAR.

THE Behar Sugar Commission, which was appointed in October of last year to see whether improvements might not be made in the cultivation and manufacture of cane sugar, has completed its task. The report has been issued with commendable promptitude—scarcely five months having elapsed from the appointment of the Commission to the presentation of its report. The Commission was primarily appointed because of the perilous position of the indigo industry, to see whether it might not be possible to grow the sugar cane and indigo crops in rotation.

The *Times* of April 15 contains an article upon this report. One thing the Commission seems to have made clear is that the methods employed in the sugar industry have been on the same happy-go-lucky slip-shod fashion as those until lately used in the manufacture of natural indigo. The yield of sugar per acre in India averages about one ton, whereas in Barbadoes it is three tons, and four tons are obtained in Java.

The Indian Government, taking alarm at the great increase in the imports of beet sugar and wishing to aid the indigenous planter, imposed countervailing duties in March 1899. The duties have apparently failed in their object, as the imports of beet sugar for 1900 were greater than for 1898. It would appear that very little attempt has been made in India "to treat the soil or plant the canes on scientific principles," and that the methods of refining the sugar are rough, crude and wasteful, so that under such conditions the yield of the finished article is not what it should be, and the quality is poor; Indian sugar is, therefore, unable to compete with sugar refined by modern scientific methods and appliances.

It is further stated that there is an increasing tendency in India to prefer sugar which has been refined to unrefined sugar. The Commission recommend the employment of modern and up-to-date apparatus. We are glad to note that they do not recommend indiscriminate help to the individual planter or refiner, but suggest that such assistance as is desirable should be given in helping systematic experiments at a central station.

Turning now to the indigo industry, which was the primary cause of the appointment of the Commission, we find that the indigo planter, now thoroughly alive to the danger which threatens him, is exerting himself to improve the yield of indigo. In the first place, by the employment of artificial manures, principally superphosphates, an increased plant production of from 50 to 100 per cent. has been obtained. In manufacturing indigo, it will be remembered (NATURE, November 1) that it is usual, when the plant has reached maturity, to cut it near to the ground and to steep the whole plant. After a few months the fresh shoots which have sprung up are again cut, but the yield of indigo from this second crop is inferior to that obtained from the first. It has been suggested, seeing that almost the whole of the colouring matter is contained in the leaves, that the plant should not be cut down, but that the leaves only should be stripped off and steeped. It is calculated that four or five strippings could be obtained during the manufacturing season, and thus a very much larger quantity of indigo would be produced than by the methods at present in vogue.

The old beating process for oxidising the liquors obtained after the plant has been steeped is gradually being replaced by the use of the "blower." In this method air is blown through a number of perforated pipes which are placed at the bottom of the vats, with the result that oxidation is more rapid and complete, and about 25 to 30 per cent. more colouring matter is produced than by the old process. Mr. Rawson, in addressing a meeting of those interested in the indigo industry at Calcutta on February 20, said that the output of indigo in North Behar last year amounted to about 60,000 maunds,[1] and that at least 12,000 maunds more would have been produced had the new "blowing" process been employed.

A manufacturing industry, such as that of indigo, which is to a large extent dependent upon atmospheric conditions, has naturally seen many dark days. But when the supply has been short there has generally been an enhancement in prices. The Commission is of opinion that a rise of price owing to bad seasons or short supplies can no longer be looked for, and say in their report: "It is reasonable to anticipate that the competition of synthetic indigo will prevent any future increase in the price of vegetable indigo, that it will soonest and most injuriously affect the finest and most expensive indigo, which is that of Behar, and cause a further reduction in price, which would hardly clear the planter in a good season, while a bad season would be ruinous to him." They go on to say, "it is obviously expedient that indigo planters should possess in sugar and other products resources which, if they are carefully and intelligently utilised, will enable them to contemplate the future of indigo with equanimity."

In order to aid the Indian indigo industry, the Bengal Government has formally agreed to grant an annual subsidy of 50,000 rupees for three years for further chemical and scientific researches with regard to indigo cultivation.

Indigo planters claim that at present the natural dye can be placed on the market at prices which can undersell the synthetic product. This is good news, but it is difficult to see how it is in the long run to hold its own against the artificial product, which is of uniform quality, requires no grinding, and is unaffected by vicissitudes of weather.

Prof. Armstrong, in a long letter to the *Times*, says that "The truly serious side of the matter, however, is not the prospective loss of the entire indigo industry so much as the fact that an achievement such as that of the Badische Company seems to be past praying for here."

Whether or not the natural indigo industry is to become a thing of the past remains to be seen, but if the replacement of natural indigo by a synthetic article produced in Germany leads British manufacturers to realise more fully the importance of trained scientific assistance, the decline, although in itself a great calamity, might not be entirely without its compensations.

Since writing the above, I have received a copy of an address upon "The Synthesis of Indigo," delivered by Prof. Meldola before the Society of Arts on April 17. In introducing the subject Prof. Meldola says that it is now often considered unpatriotic to "call public attention to any branch of industry in which we are being beaten by foreign competitors." He, however, considers that "The real enemies of British industry are those who, by virtue of their positions as politicians, economists, or as men of science, try to blind the public and to allure the manufacturer and merchant into a fool's paradise of false security."

[1] The Bengal factory maund is 74·66 lbs.

Then follows a very lucid and interesting historical survey of the chemistry of synthetic indigo. Attention is called to the fact that the first patent bears the date of March 19, 1880, and that although we knew that artificial indigo prepared by this, the cinnamic acid synthesis, could not compete with the natural product, yet its appearance caused much consternation among indigo planters. But because the threatened storm did not break, the planters evidently quickly forgot their fright and returned complacently to their old rule-of-thumb methods. Not so the chemists; they steadily and perseveringly plodded on, and in 1882 von Baeyer and Drewson brought out another synthesis, viz. the condensation of acetone and orthonitrobenzaldehyde in presence of caustic alkali. This process, or a modification of it, is employed at the present by the firm of Messrs. Meister, Lucius and Brunning; but as the supply of the raw material—toluene—is limited, Prof. Meldola, speaking as an individual, says: "Were I a planter, I should have no anxiety whatever with respect to a competing product which starts from toluene." Every 1000 gallons of coal tar yields about $6\frac{3}{4}$ gallons of benzene and $3\frac{1}{4}$ gallons of toluene, therefore any process which started with benzene as the out-going product should be better able to compete than one in which toluene is the starting material. However, although there are several syntheses which start from aniline (produced from benzene), the methods employed are so costly that at present the planter has very little to fear in this direction.

Naturally the chief portion of the paper is devoted to Heumann's synthesis, as at present worked by the Badische Company. This process, which starts from naphthalene, the supplies of which are practically unlimited, was described in NATURE, November 29.

In his references to the Badische Company Prof. Meldola quoted the following facts from the official report prepared for the Paris Exhibition:—

"The factory at Ludwigshafen employs 148 *scientific* chemists, 75 engineers and technical experts, and 305 members of the mercantile staff. In 1865 they commenced with 30 workmen, and they now employ over 6000. The consumption of coal is about 243,000 tons per annum; water is supplied to the factory to the extent of some 20,000,000 cubic metres annually; they make 12,000,000 kilogrammes of ice, and over 12,000,000 cubic metres of coal gas in the course of the year. The electric installation consists of eight dynamos, the currents from which serve for illumination, motive power and electrolytic processes. Steam is supplied from 102 boilers, which serves for heating purposes and for driving 253 steam engines."

Let the British manufacturer and the Indian indigo planter try to digest these hard facts and figures. I wonder whether there are 148 *scientific* chemists employed by manufacturers in the whole of the United Kingdom. Let them also remember that these figures only refer to *one* firm.

Finally, Prof. Meldola refers to the natural product *versus* synthetical indigo. He is unable to hold out the hope that the natural article will in the long run be able to compete with the product of the German factory. "The planters have allowed twenty years of activity on the part of the chemists to pass by with apathy and indifference, and at the last moment only have they called in expert assistance."

It is truly marvellous that only the British planter should have been so lethargic. In Java the Dutch planters "have had the wisdom to avail themselves of the resources of the botanical gardens for experimental purposes, and their chemists and bacteriologists working in Holland in co-operation with the planters have, as is well known, for many years past been contributing to chemical literature the results of their investigations."

Reference is made to the contradictory opinions as to what goes on in the steeping vats, as to whether the resolution of the glucoside indican into indigotin is due to bacterial fermentation, or whether it is one of ordinary zymolysis. Attention is also directed to the drying process, which often extends over several weeks, and during which time it is stated that a fungus grows on the cakes and ammonia is evolved. Prof. Meldola asks whether this may not be due to the destruction of indigo by a micro-organism. I have myself often wondered that in all the suggestions for improving the yield and quality of indigo no one appears to have drawn attention to this apparent decomposition. It seems possible that more thorough washing and rapid drying in a current of hot air would perhaps prevent this. In his closing remarks Prof. Meldola refers to the antiquity of the industry, and questions whether the methods at present employed in India are very different to those used in the time of the Pharaohs.

F. MOLLWO PERKIN.

THE OLDER CIVILISATION OF GREECE.[1]

THE sixth volume of the *Annual of the British School at Athens* contains matter of extraordinary interest to students of the history, not only of Greece, of Egypt and Western Asia, but also of mankind in general. The culture which now dominates the world is the child of the civilisation of Ancient Greece, and any archæological discovery which tends to increase our knowledge of the beginnings of Greek civilisation possesses an importance and an interest far greater than that of any other possible discovery whatever in the archæological field.

For the last twenty years, since Schliemann first unveiled the treasures of the citadel of Mycenæ, it has been recognised that the culture of classical Greece as we know it is but the second epoch of Greek civilisation. Classical Greece had a past the true history of which had been half forgotten, had been preserved in confused and contradictory legends. The culture of the past had bloomed from end to end of the Greek world, in cities, some like Athens or Knôssos, of renown in classical as well as præ-classical days, others like Mycenæ and Tiryns, cities whose fame ceased to be when the Dorians entered Greece. This culture was bronze-using, and was, in fact, the Greek phase of the European culture of the Bronze Age, a phase earlier in date than the phases of Central and Northern Europe, and in all probability not only their forerunner, but to a great extent their forbear. This culture itself developed out of a stage of transition from Neolithic barbarism, which we call "præ-Mycenæan," during which stone, copper, and occasionally bronze, were used side by side, pottery was rude and unpainted, and the dead were buried in *cist-graves*. This stage shades off on the one side (as in the first city of Troy) into the Neolithic culture, on the other (as in Cyprus) into Mycenæan civilisation, which marks the first stage of real "civilisation," properly so-called, in Europe. The earliest stages of the Mycenæan culture are known to us from discoveries of settlements with pottery, &c., in Thêra, at Phylákopê in Melos, at Kamárais in Crete, and other isolated spots, chiefly in the Southern Ægean islands. The civilisation which we find at Mycenæ, at Vaphio, at Ialysos and elsewhere, is the same as that of Phylákopê and Kamárais, but is more highly developed in many ways. This can only be the culture of the heroic Achaians, which was overthrown by the Dorians; its date must, then, be placed certainly before 900 B.C., even if, as is very possible, it continued to exist in Western Asia Minor and Cyprus till the eighth century. We can be more certain about its date than this; Mycenæan culture was by no means confined to

[1] *The Annual of the British School at Athens*; No. VI. Session 1899–1900. Pp. viii + 156. With illustrations and two maps. Printed for the subscribers and sold on their behalf by Macmillan and Co., Ltd. Price 10*s*. 6*d*.

Greece, and there were ships and sailors in those days as bold and venturesome as any of the time of Elizabeth. We know from the Egyptian State archives of the reign of King Akhunâten (B.C. 1430; date determined by synchronism with Burraburiyash of Babylonia, B.C. 1430) that in the XVth century B.C. the Phœnician cities already traded with many lands across the seas, with Egyptian Thebes, with Alashiya or Cyprus (?), and with *Keftiu*. The people of *Keftiu* came to the court of King Thothmes III. of Egypt (B.C. 1550) with gifts.

Where was *Keftiu*? Mr. A. J. Evans tells us this in this sixth volume of the *Annual of the British School at Athens*.

Mr. Evans's excavations at Kephala, the site of Knôssos, in Crete, are the culmination of many attempts, pursued during several years past under difficulties of all kinds, to elucidate the early history of Greek civilisation in Crete. The traditions of the island point to its having occupied a position of especial prominence in the Mycenæan world, and Mr. Evans's hopes of great results from Cretan exploration have not been disappointed. He has not only discovered at Knôssos a Mycenæan palace of the first rank, which is very probably identical with the legendary "Labyrinth" of Minôs, but has also discovered that the Mycenæans of Crete were in all probability the same people as the "Men of *Keftiu* and of the Isles in the midst of the Very Green" (*i.e.* the Mediterranean), who make their appearance in Egyptian history *c.* 1550 B.C., thus giving the earliest trustworthy date for the Mycenæan civilisation.

Not only the palace, but also the Mycenæan town of Knôssos was discovered in the course of these excavations. The exploration of the town ruins was carried on by Mr. D. G. Hogarth, late Director of the British School at Athens, Mr. Evans busying himself more especially with the exploration of the palace. It is noteworthy that vases and fragments of vases found in the town ruins were of the early Mycenæan or "Kamárais" type, while those found in the palace mostly belonged to the fully-developed Mycenæan types so well known to students of early Greek art from the great work of Messrs. Furtwängler and Löschcke. This does not necessarily mean that the town-ruins are all older than the palace; all that is implied is that the palace, which from various indications was evidently already in existence in the "Kamárais-period," continued to be occupied down to the period of its sudden sack and destruction by fire towards the end of the Mycenæan age, at which time only vessels of the later type were in use, while in the town we have two strata of settlement, the one containing the vases of the earlier period, the other those of the later generations of inhabitants. There need be no question of a change of race here, though Mr. Hogarth seems to suggest it. Alteration of style in art is no proof of racial change. Such changes are simply due to an alteration of fashion, suddenly started by some artist. We have an example of a sudden alteration of the kind in Egypt in the early years of the XVIIIth Dynasty. But we do not therefore in this case assume the violent substitution of one race of inhabitants by another. Even alteration of burial customs is no clear proof of change of race.

Important as the relics of the "Kamárais-period" from the Knôssian town are, however, they pale before the importance of the discoveries made in the palace itself. The excavation of this, probably the most important Mycenæan building yet discovered, is only begun, and we know not how Mr. Evans may increase our knowledge of the older civilisation of Greece in the course of his diggings this year. What he found last year, however, gives us material enough to think about! The plan of the palace shows a vast labyrinth of chambers, halls, corridors and passages; a true labyrinth indeed, for it is the only genuine and original Labyrinth itself, as the constantly-recurring symbol of the double-axe, the emblem of the later Zeus of Λαβραυ-νδα, which is etymologically the same word as Λαβύρι-νθος, "The Place of the Λάβρυς or Double-Axe" (for the earliest Mycenæans of Knôssos and elsewhere were not Aryan Hellenes, but "Pelasgians" allied to the non-Aryan peoples of Asia Minor), the emblem of the Knôssian Zeus, Ζεὺς ἄναξ, Πελασγικὸς, shows. This is the labyrinth of Minôs: is the bull-headed Minotaur, child of Zeus, of whom legends passed to the succeeding Hellenic inhabitants of the land, the recollection of some Mycenæan deity to whom human sacrifice was offered at Knôssos? We know the love of the Mycenæans for bulls, we see the *protomae* of bulls at Mycenæ and among the gifts of the *Keftiu*, we find pictures of ταυροκαθάψια, bull-catching, at Tiryns and elsewhere, we have the splendid life-sized relief of a bull's head in painted *gesso duro* from Knôssos itself (Fig. 10

Fig. 1.—Protomycenæan Vases from Knôssos: probable date before 1600 B.C.

of the work under review); there are hundreds of other instances. The bull was the beast of Zeus: the idea of a Phœnician origin of the Minotaur is just so much rubbish; he is a purely Mycenæan conception. And his master, Minôs? What would Mr. Grote have said had he been told that in 1901 the name of Minôs would pass

FIG. 2.—The Fifth Magazine, showing Great *Pithoi* and Receptacles in the Floor.

from the realms of pure myth into those of historical probability? Yet we have what look very much like the remains of a great Cretan power dating long before the Return of the Herakleids, in fact the power and kingdom of Minôs. The evidence of Greek legend can no longer be scoffed at, and the tradition of the Minoan thalassocracy may yet be shown to contain a substratum of historical fact. Those *Keftiu* went far afield: they reached Egypt. Sicily and Kamikos are no farther.

The records of Knôssos have much to tell us, but as yet they are dumb. There they lie before us, those queer characters incised on tablets of sun-baked clay, but we cannot read them yet. How long we shall continue in this state of tantalising ignorance it is impossible to tell. The lamentable failure to read the so-called "Hittite" script of Eastern Asia Minor is no good augury. This discovery of inscribed tablets is the most important in the field of early Greek antiquities since the excavation of the graves at Mycenæ. The tablets, good illustrations of which are given by Mr. Evans, were found in a number of deposits or "hoards" in the palace, mostly packed away in sealed boxes placed in large πίθοι or handleless vases (a specimen of the kind, brought from Rhodes, is in the First Vase Room of the British Museum), which were stored in special chambers. The writing is of two kinds, hieroglyphic ("pictographic") and linear: in both remarkable resemblances to Egyptian characters are noticeable, and give further proof of the idea, now fast gaining ground, that Egypt exercised no little influence upon the development of Mycenæan culture. On the other hand, the use of clay for the tablets is a sure sign of the influence of the rival civilisation of Babylonia. Many of the tablets evidently contain simply lists of ships, chariots, horses, swine, &c.; so much we can guess from the pictures. The numerical system is evident; further than this we cannot go. It had long seemed curious that the highly-developed civilisation of Mycenæan days should have been ignorant of the art of writing; but we had no conclusive proof of Mycenæan writing before Mr. Evans's epoch-making discovery. Now here are the records of the Mycenæans before our eyes; σήματα λυγρά, indeed! They will not want for energetic "Bearbeitung," and the Clarendon Press is already preparing a fount of Mycenæan type! But the omens are bad.

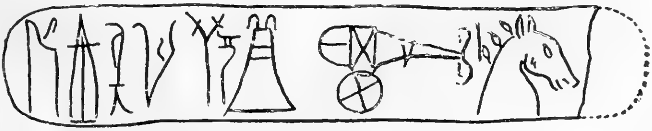


FIG. 3.—Linear Tablet referring to Chariot and Horses and, perhaps, Cuirass. (Size of original.)

We have remarked that Mr. Evans has shown that the *Keftiu* who brought gifts to the court of Thothmes III. of Egypt, *c.* 1550 B.C., were Mycenæan Cretans. This conclusion is a legitimate one. Some of the finest known examples of Mycenæan fresco-painting have been found in the Knôssian palace, and among them are representations of processions of men bearing vases, &c., who in dress are absolutely identical, on the one hand, with the bull-catchers of the Vaphio cups, on the other with the *Keftiu* who are depicted on the walls of Rekhmarā's tomb at Thebes, in Egypt. No doubt of the identity is possible; the further presumption that the pictures of Rekhmarā's tomb are roughly contemporaneous with the frescoes of Knôssos is backed up by the cumulative force of all the rest of the chronological evidence, besides being inherently probable from the almost exact similarity of costume, &c. The date of *c.* 1550 B.C. for the *later* portions of the Mycenæan palace at Knôssos is thus clearly indicated.

These frescoes give us an inkling of the racial type of the Mycenæans. They are not fair-haired Aryans at all. They are brunett, black-haired, un-Aryan people like the modern Italians, Greeks and Anatolians; they belong, in effect, to the "Stirpe Mediterranea" of Sergi, the race which we may, if we like, call Pelasgian, which preceded the Aryans in Greece as well as in Asia Minor, and of whose peculiar language-type Karian and Lycian give us a good idea. The Aryan conquerors gave Aryan languages to Italy, Greece and Phrygia, but the modern speakers of Italian, of Greek, and of Armenian much more closely resemble their non-Aryan ancestors than their Aryan conquerors.

The palace of Knôssos was built of great gypsum and limestone blocks, and when complete must have been a most imposing building. One of the most curious facts with regard to it is that it is really built round a small open space, which Mr. Evans speaks of as "The Central Clay Area." "This enclosure," says Mr. Evans (p. 17) "turned out to be entirely devoid of foundations, and its floor was composed of the pale clay already noticed as being of artificial accumulation and as probably due to the disintegration of the clay platforms and wattle-and-daub huts of a very primitive settlement. It was found to be full of Neolithic relics, and a shaft sunk near the N.W. corner showed that the deposit was at this point 7·50 m. in thickness. On the south side this clay deposit merges in a darker soil full of wood-ashes and bones, possibly of a sacrificial nature. The existence of this early site, untouched in the middle of the later palace, suggests curious speculations. We have here, perhaps, the interior of a *temenos* preserved for religious reasons, and the square base of an altar, already noticed, in the eastern bay of the enclosure, confirms the idea of consecration. It may be that the 'Palatine' of Mycenæan Knôssos also had its 'Casa Romuli'—a sacral survival of a prehistoric dwelling."

A chamber of great importance in the palace was the Throne-room, of which Mr. Evans gives a description (p. 35 ff.): "The chamber . . . was in many ways as perfect as the room of a Pompeian house, though some fourteen centuries earlier in date. On the south side opened an impluvium and steps leading down to a fine stone tank. . . . . Breasting this, and along two other sides of the room, ran gypsum benches with pilasters. . . . At the middle of the north wall was an interval between two of these stone benches, the central post of which was occupied by a gypsum throne. The throne rested on a square base and displayed a high back of undulating leaf-shaped outline. . . . Its total height is 1·06 m., and the level of the seat 0·56, or 21 cm. above that of the stone benches. . . . The lower face of the throne presented a curious architectural relief, consisting of a double moulded arch springing from flat, fluted pilasters, expanding upwards in the Mycenæan fashion. The upper part of this arch was traversed by a moulded band forming a counter-curve. But the most interesting feature remains to be described. The lower part of the mouldings of the arch on either side were, by a strange anticipation of later Gothic, adorned with bud-like crockets. The architectural features, indeed, revealed by these reliefs are in almost every respect unique in ancient art."

FIG. 4.—Throne-Room as seen from Antechamber.

A splendid idea of this room and of the now famous "Throne of Minôs," can be obtained from the photographs published in the *Annual*, one of which is shown in Fig. 4. In general it may be said that the illustrations are extremely good—the plans also. But for finality in these latter we must wait till Messrs. Evans and Hogarth have brought their excavations to an end. Enough has now been said to give the reader an idea of the immense importance of the discoveries at Knôssos, and it is a matter of congratulation that their discovery has fallen to the lot of an Englishman. Our knowledge of early Greek civilisation in Crete now rests on a much surer foundation than it did when Mr. Evans strove to draw a connected story from the evidence of the "Seal-stones" alone.

To one small point only in Mr. Evans's discussion of his discoveries must we take exception. When speaking of the inscribed tablets he says (p. 57): "Some distant analogy may be recognised with the tablets of Babylonia, but the letters here are of free upright 'European' aspect, far more advanced in type than the cuneiform characters. They are equally ahead of Egyptian hieroglyphs, though here and there the pictorial original of some of these linear forms can still be detected." This passage is very incomprehensible. In the first place the whole idea of the Knôssian tablets is obviously of Babylonian origin: they are not merely "distantly analogous" with the tablets of Babylonia. In the second place, what does Mr. Evans mean by the Mycenæan letters being "of free upright 'European' aspect"? What characters can be called free or unfree? Why is the erect position specially "free" or "European"? The Egyptian hieroglyphs and their hieratic developments stood bolt upright unless a crocodile or a snake were pictured; cuneiform was upright and spiky enough, in all conscience. They are not European. With what European script is he comparing the Mycenæan writing? Surely not with the Greek alphabet, which was of Phœnician, and ultimately of Egyptian, origin. And how are the Knôssian characters more advanced in type than the cuneiform characters? Obviously they are nothing of the kind; they are in the same stage of development as the Egyptian hieratic writing, to which they bear a strong resemblance; so far, then, it may be said that they are "ahead" of the Egyptian hieroglyphs; but cuneiform was far more conventionalised, far "ahead" of either Egyptian hieroglyphic and hieratic or Mycenæan linear. The people who used the Knôssian script may turn out to have had not one drop of Aryan "European" blood in them, and European-Greek culture may be as thoroughly of non-Aryan (and equally non-Semitic) origin as Semitic culture was in its origin absolutely non-Semitic.

The work of Messrs. Evans and Hogarth at Knôssos has been supplemented by the latter with the very interesting results of his excavation of the famous cave of Zeus on Mount Diktê, an account of which appears on p. 94, ff. Mr. Hogarth's story of his operations, of the blasting of the rocks, the unveiling of the most ancient sanctuary of Zeus, the recovery of small bronze double-axes and other votive objects, belonging to the same period as the Knôssian palace, from the crevices of the stalagmitic deposit in which they had remained undisturbed for nearly four thousand years, the finding of a little Egyptian bronze statuette of Amen-Rā, which shows that somewhere about 1000 B.C. King Zeus was already identified with Amonrasuntiru, Amen-Rā, king of the gods—all this is of the highest archæological interest, and may be recommended to the notice of students of Greek religion.

It remains to speak of the articles of less importance which also find a place in this number of the *Annual*. That by Mr. F. B. Welch on "The Influence of the Ægean Civilisation on South Palestine" is important as chronicling the occurrence of Mycenæan pottery at a Palestinian site, Tell es-Safi. "This," says Mr. Welch, "was certainly a Philistine stronghold, a fact which is suggestive in view of the probable north-western origin of the Philistines" (p. 119). This is quite true, and it may be remarked that the old tradition of the Cretan origin of the Philistines has lately, in view of the Egyptian records of attacks by the Peoples of the Sea, among whom figure the *Pulesatha* or Philistines, and a great deal of other evidence, both archæological and legendary, come once more to the front, and probably represents a historical fact. But Mr. Welch should note that Semitic authorities such as Delitzsch, Jensen, Mayer and Tiele uncompromisingly claim the Philistines as Semites, and specifically Aramæans. The Egyptian evidence, however, as Mr. Welch rightly implies, goes absolutely against the Semitic claim, which will probably have to be given up. Still, the Greek archæologists have no right to ignore the opinion of the Semitists on such a question as this. Mr. Welch seems, by the way, to attach rather too much importance to purely "typological" arguments derived solely from the study of pottery, which can never be an absolutely infallible guide.

Mr. J. C. Lawson's note on "A Beast-Dance in Scyros" (p. 125) will be of great interest to anthropologists. In carnival time the young men of Scyros array themselves in goat-skin capes—"each does his best according to his lights and his means to look like a goat"—hang goat-bells round their persons and solemnly dance through the town, often stopping "at some friendly door to imbibe spirituous encouragement to further efforts." This is undoubtedly a very ancient survival, and possibly goes back to Mycenæan times, a surmise with which anybody who knows what a great part goat-headed and other theriomorphic figures play in Mycenæan art will probably agree. But alas, "thanks to the steadily increasing influx of Western culture during the last few years," the goat-mask is often replaced nowadays by "an Ally Sloper mask"! The modern Japanese wears a billycock or a deerstalker on the top of his national historical costume. So the free and upright civilisation of modern Europe dominates the world!

It may be finally noted that the knowledge which the contributors to this number of the *Annual* possess of the German language appears to be defective. If German terms are used at all, their proper plural forms should be given to them. "Bügelkannes" may be Dutch, but is neither German nor English; Mr. Welch gets over the difficulty, which might have been solved by reference to a German grammar, by giving his German words no plural form at all. He speaks of "Bügelkanne" and "Schnabelkanne" when he means *Bügelkannen* and *Schnabelkannen*.

Despite these little imperfections, the sixth number of the *Annual of the British School at Athens* is undoubtedly the most important contribution to our knowledge of the early history of mankind that has appeared for many years.

MAGNETIC OBSERVATIONS DURING TOTAL SOLAR ECLIPSE.

THE effect produced by a solar eclipse on the meteorological conditions of the atmosphere has on many occasions in the past been the subject of observation, but in the number of *Terrestrial Magnetism* just received we find an account[1] of a systematic examination of the influence of such an eclipse on magnetic conditions also. It had appeared to Dr. Bauer, chief of the U.S. Magnetic Survey, that magnetic observations might on such an occasion be usefully undertaken; and the occurrence of the solar eclipse of May 28 of last year, the total phase of which was visible in the United States, afforded an excellent opportunity of carrying such design into execution. For the needs of the magnetic survey simultaneous magnetic observations are made on certain days throughout the year at the different magnetic stations, and it was arranged that such observations should be made, on the day of eclipse, at stations as near as possible to the path of totality. Six stations were selected; three of them—Union Springs, Rocky Mount and Cape Charles—were situated within the path of totality, the remaining three—Salem, Bayard and Gaithersburg—being outside. The observers received instructions to occupy such stations as their special work permitted for the due accomplishment of the object in view, accompanied by a detailed scheme of the observations to be made. The prescribed course was carried out by all the observers excepting the one at Gaithersburg, who for some reason failed to receive his instructions in time; but he made observations according to directions sent him previously, relating to other work. The detailed scheme of observations is given with the view of aiding observers making preparations for similar work on future occasions. The observations made are discussed at considerable length, being accompanied by numerous graphical illustrations, and it is stated that there can be no question that some kind of magnetic disturbance made itself felt on May 28 at every one of the stations.

Finally, the conclusions arrived at are given under eleven separate heads, the principal points of which are contained in the following summary:—A small magnetic oscillation made itself felt at various stations situated in the eastern part of the United States during the time of the eclipse. It was detected by various persons, at various stations, with different instruments, under different conditions, and was also automatically recorded.

[1] *Résumé* of magnetic observations made chiefly by the United States Coast and Geodetic Survey on the day of the total solar eclipse May 28, 1900.

The various phases of the oscillation did not take place at the different stations at the same absolute time, or local time, but in every instance were associated with the time of maximum obscuration of the sun. The duration of the oscillation was apparently about the same as that of the eclipse, about two and a half hours. The range of the oscillation was about one minute in arc for declination, and about eight units in the fifth decimal C.G.S. for horizontal intensity, that is, to about 1/2800th part of the absolute horizontal intensity. The general effect was to deflect the declination needle to the west, and decrease the horizontal intensity, before the time of maximum obscuration, the movement afterwards being in both cases in the opposite direction. The analysis indicates that the cause producing the magnetic oscillation was situated outside of the earth's crust, the presumption being very strong that the oscillation is to be referred to some change produced in the upper atmospheric regions by the abstraction of the sun's rays, due to interposition of the moon.

Dr. Bauer expresses himself as having been in doubt before making the observations as to whether any magnetic effect referable to the eclipse would reveal itself, and adds that he was afterwards slow to conclude that the magnetic oscillation observed was not accidentally connected with the eclipse, until he had made such exhaustive examination of every point involved as justified him in formulating a definite conclusion. The result is interesting, and makes it desirable, as he says, that every opportunity should in future be taken to obtain, during eclipses, simultaneous magnetic, atmospheric-electric and meteorological observations at as many stations as possible.

It is to be remarked that, although Dr. Bauer eventually speaks with some confidence as to the magnetic movement observed having relation with the eclipse, the movement in question was small, and, abstractedly speaking, much too small on which to found any certain conclusion, considering the abundance of magnetic movements of similar and even greater magnitude. The circumstance that seems really to give weight to the conclusion drawn is the statement that the various phases of the magnetic oscillation were associated with the time of maximum obscuration of the sun. Confirmation of this circumstance is therefore what is now to be desired.

Following the paper there is printed an appeal for international co-operation in magnetic and allied observations during the total solar eclipse of May 17 next.

WILLIAM ELLIS.

PROF. H. A. ROWLAND.

HENRY AUGUSTUS ROWLAND was born in 1848. He was educated as an engineer, and graduated at the Rensselaer Polytechnic at Troy, New York, in 1870. After one year's experience as a railway engineer on the Western New York line, and a second spent as instructor in natural science at Wooster, Ohio, he returned to his college to share in its teaching, becoming an assistant professor in 1874. Two years later, in 1876, after spending a year under Helmholtz in Berlin he took office as the first professor of physics at the newly founded Johns Hopkins University. Baltimore remained his home until his death, on April 16, at the early age of fifty-three years.

His work at Berlin on the magnetic efforts due to a moving body when carrying an electric charge brought him at once into fame. The result was published by von Helmholtz in 1876, and is thus described by Maxwell in a metrical letter to Tait, written in June, 1877. Tait had inquired, also in verse, as to the electric effects to be expected if a disc of ebonite carrying a charge were made to rotate in its own plane, and Maxwell writes :

> The mounted disk of ebonite
> Has whirled before nor whirled in vain,
> Rowland of Troy, that doughty knight,
> Convection currents did obtain,
> In such a disk, of power to wheedle
> From its loved north the subtle needle.

Rowland showed by the direct effects produced on a magnetic needle that a charged body in motion gave rise to a magnetic field just as though it were a current whose strength depended on the product of the charge and the velocity.

This result is of fundamental importance to electrical theory ; it was confirmed by Rowland and Hutchinson in 1889, and has been generally accepted as an established fact. Within the last few months, however, Cremieu has published an account of a repetition of Rowland's experiments which has led him to a negative result ; the question just at the present moment appears to need further investigation.

Rowland's appointment at Baltimore was rapidly followed by a series of brilliant researches, each of the first importance. His determination of the unit of resistance came first. This was published in 1878. The original B.A. units were constructed by the Electrical Standards Committee in 1863-4 to represent 10^9 C.G.S. units of resistance ; according to Kohlrausch's results in 1870 they were 2 per cent. too high, while according to Lorenz (1873) they were 2 per cent. too low. Rowland's paper contains an able criticism of the old experiments and a detailed account of his own which led him to the number $\cdot 9912 \times 10^9$ C.G.S. units as the value of the B.A. units. Further experiments in 1887 reduced this to $\cdot 9864 \times 10^9$. The value now generally accepted is $\cdot 98653 \times 10^9$. Rowland himself employed a modification of Kirchhoff's original method, in which the induction current in a secondary circuit produced by reversing a measured primary current in a neighbouring circuit is observed.

In 1879 Rowland presented to the American Academy of Arts and Sciences his paper on the mechanical equivalent of heat, with subsidiary experiments on the variation of the mercurial from the air thermometer, and on the variation of the specific heat of water. To attempt to give any account of the contents of this classic work would occupy too much space. To appreciate its value and to realise the skill and the ingenuity of its author it must be studied itself. More is known now about exact thermometry and the precautions necessary in using a mercury thermometer, and so it has come about that some corrections are necessary in Rowland's work, specially in that part of it which deals with the relation between the scales of the mercury and the air thermometer. These corrections were made at the Johns Hopkins University by Messrs. Day and Wardner and Mallory ; but this fact detracts nothing from the importance of his investigation, and among the many determinations of the value of Joule's equivalent, Rowland's will always remain in the first rank.

Passing over, for the present, much work of great value, among which we may note his investigations into the magnetic permeability of various substances, published in the *Philosophical Magazine* for 1873 and 1874, and his theory of Hall's effect, we come next to the year 1882, when Rowland gave to the Physical Society of London an account of his concave grating. This is published in the *Philosophical Magazine* for September, 1883.

The results of this discovery are well known. A new weapon was placed in the hands of spectroscopists ; it became possible to photograph spectra directly without the use of prisms or lenses, and with a greatly increased dispersion and resolving power ; the beautiful maps issued at a later date by Rowland himself, and by Higgs of Liverpool, are striking evidences of the value of the grating ; the additions to our knowledge arising from this one discovery are already enormous ; much has been achieved which, without it, would have been impossible.

Rowland's own researches with his grating are summed up in his map of the solar spectrum and his table of the wave-lengths of the elements, published in 1893 (*Phil. Mag.*, July, 1893, reprinted from *Astronomy- and Astro-Physics.*)

Of late years he gave much time and attention to a system of multiple telegraphy; this was shown working at the Paris Exhibition last year.

Enough has been written, perhaps, to indicate the debt physical science owes to Rowland; it is said he never received any regular instruction in physics; he was an engineer, and to this, in great measure, his success is due. The accuracy of his work on the ohm depends on the care he took to construct his induction coils so that their dimensions could be accurately measured; he dealt with the determination of the mechanical equivalent as an engineering problem; he employed a large mass of water and used steam power to rotate his paddle at a speed sufficient to make the resulting rise in temperature one that could be measured with accuracy.

The theory of the concave grating was his, but its success was due to the fact that Rowland had made an almost perfect screw; the method he employed in this in given in his article, "Screw," in the "Encyclopædia Britannica."

He lived for his work, but in his earlier days he was passionately fond of riding. Some years after the publication of the paper on the mechanical equivalent he was awarded a prize for it by one of the Italian Academies; about the same time he won a steeple chase, riding his own horse; he hardly knew which event gave him the greater pleasure. Another time, passing through England on his way home from the Continent, he had three days to spare. One of these was passed at Cambridge discussing electrical measurements, the other two were spent in a hurried visit to Exmoor to get a run with the staghounds. Twenty years ago he was a frequent visitor to England, and attended several of the meetings of the British Association; recently his visits were much less frequent. His friends here were aware that he was not well; some few weeks ago it was known that he had had a serious illness, but the news then was that he was better and on the road to recovery; however, an operation proved necessary, and he never recovered from its effects.

Thus within the last few months physical science is the poorer by the deaths of two of the most brilliant of the followers of Maxwell—Fitzgerald and Rowland; two who were foremost among those who have given to the theory of Faraday and Maxwell the right to claim the position of the theory of the electro-magnetic field.

R. T. G.

PROF. FRANÇOIS MARIE RAOULT.

FRANÇOIS RAOULT, professor of chemistry at Grenoble, died there on April 1 after a short illness. In him France has lost one of her most distinguished men of science, whose discoveries have supplied material for theoretical considerations which, within the past fifteen years, have had a most profound influence on chemistry and physics.

Raoult was born on May 10, 1830, at Fournes (Nord). His father, an officer in the local customs' service of Villers Cotterêts (Aisne), sent the boy to school at Laon, with the intention of his afterwards entering Government service. But Raoult's tastes lay in a different direction; and with the full consent of his father he finished his school career at Paris, and entered the scholastic profession. He began his teaching career at the age of 23 in the Lycée at Reims, and was shortly afterwards transferred to the Collège of Saint Dié; while there he graduated as B. ès Lettres, and B. ès Sciences, passed his "Licencié" examination, and was appointed "Agrégé" of special secondary instruction. On presenting a thesis on "The Electromotive Forces of Voltaic Cells" he gained the title of "Docteur ès Sciences Physiques," and four years later, in 1870, he obtained the chair of chemistry at Grenoble, where he passed the rest of his life in constant labour in teaching and research during a period of 31 years. In 1889 he was elected "doyen," or dean of the faculty, and was re-elected to this important office four times. He occupied himself largely during the last dozen years in the reorganisation of the Faculty of Science, leading to the creation of a local university at Grenoble in 1896.

The author of this notice was once informed by Raoult that he independently discovered Faraday's and Ohm's laws; he had begun to experiment on the passage of electricity through solutions before he had acquired any real knowledge of what had already been achieved. On mentioning the fact to his scientific friends at Paris he learned, to his great disappointment, that his discoveries had been anticipated; but he took comfort in the thought that if he were able to make such discoveries, of which the importance is universally recognised, he must also be able to advance science in other directions. His first scientific work, published as his thesis for the doctorate, has already been mentioned; it was published in 1863, and until 1870 he devoted himself to a study of the chemical effects of the electric current, trying to distinguish between the heat evolved by chemical reactions and that due to the electric current in the voltaic cell. From 1870 to 1886 his attention was given to subjects of a more purely chemical nature, such as the extent of inversion of cane sugar under the influence of solar radiation; the absorption of ammonia by saline solutions; the presence of copper and zinc in the animal organism; the carbonates of calcium, strontium and barium; and the influence of carbonic anhydride on respiration. His work on the absorption of ammonia led him to consider the freezing-points of the saline solutions of that gas (1878); and from that date onwards he busied himself with the freezing- and boiling-points of solutions in water and in other solvents of salts and organic compounds, publishing his results in no less than 57 memoirs in various scientific journals. His last publication, "La cryoscopie," was published in the present year (*Collection Scientia*, Carré et Naud).

Most of Raoult's apparatus was constructed with his own hands; he was rather given to accurate experimentation than to the evolution of theories. The vast mass of evidence which he accumulated relative to the lowering of the freezing-points and of the vapour-pressures of solvents by the presence of dissolved substances made it possible for van 't Hoff to draw the important deductions relative to the connection of these phenomena with osmotic pressure and with the ionic theory of Arrhenius, which will ever shed lustre on his name. And to the practical chemist Raoult's work furnished a means of determining the molecular weights of non-volatile substances—methods familiar to every student of chemistry.

His labours met with ample, though tardy, recognition. In 1889 he was awarded the *Prix Lecaze*, of 10,000 francs; and in the same year he was made *correspondant de l'Institut de France*. In 1895 he received the biennial prize of the Institute; in 1892 he was the Davy medallist of the Royal Society, and in 1898 he was elected a Foreign Fellow of the Chemical Society of London. He was chosen *Chevalier de la Legion d'Honneur* in 1890, raised to *Officier* in 1895, and last year obtained the much-coveted title of *Commandeur*. He was a member of many foreign academies and scientific societies.

Though modest and retiring, Raoult's devotion to his work, dignity of character and sweetness of temper gained him many friends. He was not an ambitious man, but was content to work on, happy if his discoveries contributed to the advancement of science. It is to the labours of such men that the progress of the world, both scientific and industrial, is due; for the methods which he introduced have led, not merely to a knowledge of the structure of many compounds which would otherwise have remained unknown, but have also had a profound influence on chemical theory, and have led to many discoveries of the utmost practical utility. He lived a happy and contented life, and even in his death his desire was satisfied; for in his discourse at the grave of his predecessor in the office of dean of the Faculty of Science at Grenoble, Lory, he gave utterance to the words:—"Puisque la mort est inévitable, ne vaut il pas mieux tomber ainsi tout entier, que de sentir la diminution lente et progressive de ses forces et de son intelligence?" Raoult died, after a few days' illness, without pain.

W. R.

DR. A. HIRSCH.

INFORMATION has reached us from the president of the Council of State for the Republic and Canton of Neuchâtel of the death, at Neuchâtel on April 18, of Dr. Adolph Hirsch, aged 71, the director of the observatory at Neuchâtel since its foundation in 1859. Dr. Hirsch was also secretary to the International Committee of Weights and Measures, established at Paris under the Metric Convention of 1875.

Dr. Hirsch contributed largely to our knowledge astronomy and meteorology, his earlier papers on the former subject having appeared in Berlin and Vienna, and his later papers, particularly with reference to the establishment and position of the new observatory in the Neuchâtel *Bulletin*. ("Établissement de l'Observatoire à Neuchâtel," *Bul.* v. 1859–1861; "Recherchés sur des Pendules Astronomiques," *Bul.* v. 1859–1861; "Découverte de deux nouvelles petites planètes," *Bul.* v. 1859–1861; "Rélation des phénomènes météorologique avec la marche des instruments magnétiques," *Bul.* vi.; "Influence des taches du Soleil sur la temperature de la Terre," 1877; Sur le passage de Venus," 1883, etc.). In more recent years Dr. Hirsch has been closely identified with the introduction of the metric system of weights and measures as an international system. He was a member of the original Commission International du Metre of 1872, of which the present eminent director of the Imperial Observatory, Dr. W. Foerster, and Dr. Von Lang, of the University of Vienna, were also members. On the establishment of the new International Committee of Weights and Measures in 1875, Dr. Hirsch became its secretary, a position which he filled until his death. A master in metrological science and a prince of secretaries, his loss will be deeply deplored by all whose opportunity it was to seek his valuable advice and to be guided by his profound experience.

NOTES.

THE gentlemen's soiree of the Royal Society will be held next Wednesday, May 8. The ladies' conversazione will not be held this year, in consequence of the death of Queen Victoria.

THE position of affairs at Coopers Hill College is most unsatisfactory. We understand that the Members of Parliament who are interested in the higher education of the country had obtained permission to move the adjournment of the House in order to discuss the latest report on the management of this institution laid before Parliament by Lord George Hamilton, but that some M.P., presumably at the instigation of the India Office, which shuns inquiry, has "blocked" this permission. This proceeding, which, unfortunately, the rules of the House allows, is but another instance of the diminishing power of the private member and the increasing domination of the Government. Lord George Hamilton stated last week that he had asked the Universities of Oxford, Cambridge and London to nominate representatives on the Board of Visitors. When reconstituted the Board is to appoint a committee to hold an inquiry into the whole working of the College. This committee can do nothing to lessen the gravity of the recent action of the Board of Visitors in the matter of the dismissed teachers. They may, however, be able to secure some sort of recognition of the professoriate in the management and policy of the College, and some diminution of the absolute power of one individual, which has recently wrought such harm both at Coopers Hill in England and at the Leland Stanford University in America.

THE reality of the connection between rats and plague is prominently brought into notice by the issue of a circular by the Local Government Board, instructing the sanitary authorities of seaports to take precautions against the entrance of plague-infected rats into this country. On the arrival in port of a vessel upon which, during the voyage, plague or sickness suspected to be plague has occurred, measures are to be taken to secure the destruction of the rats on board the vessel, and to prevent them from reaching the shore. In the case of vessels that have come from places infected with plague, strict inquiry is to be made on their arrival in port as to mortality or sickness among rats during the voyage. In the event of rats on board any ship being found to be infected with plague, all parts of the vessel frequented by those animals are, so far as possible, to be disinfected. The authorities of seaport towns invaded by plague are advised to endeavour to secure the destruction of the rats in the town, not least those inhabiting the docks and quayside warehouses. In connection with these instructions, it is worth while to bear in mind that plague is not usually transmitted by the bite of a diseased rat, but by fleas living on such rats. Experiments have shown that a healthy rat will quickly contract plague if caged with a diseased rat infested with fleas, but will not do so if the diseased rat is free from fleas. Perfectly healthy rats harbour very few fleas and are very expert in removing them, but these insects are abundant on sick rats. After death, as the body becomes cold, the fleas leave the rat, and if they reach another rat or human being they may inoculate their new host with the bacilli of plague.

PROF. BROUARDEL, Dean of the Paris Faculty of Medicine, has announced that at the end of his present term of office—namely, in February 1902—he will not accept re-appointment.

THE Rev. James Chalmers, who is reported to have been murdered in New Guinea, with the Rev. O. F. Tomkins and twelve students, was known to many anthropologists, and made some noteworthy contributions to our knowledge of the natives of New Guinea, where he passed twenty-three years of his life. His death has often been reported before now, and there is always a possibility that rumours from New Guinea will prove to be untrue; but we fear that in this case the news will be confirmed.

THE founders' medal of the Royal Geographical Society has been awarded to the Duke of the Abruzzi for his expedition to Mount St. Elias and for Arctic exploration. Dr. A. Donaldson Smith has been awarded the patrons' medal for his African expeditions and the important scientific observations made in connection with them. Awards have also been made to Mr. Louis Bernacchi and Captain Colbech for their aid in the *Southern Cross* Antarctic expedition, and to Captain Cagni for his journey to 86° 33′ N., on the Duke of the Abruzzi's expedition.

WE are reminded by the *British Medical Journal* that on October 13 Prof. Rudolf Virchow will complete his 80th year, and preparations are already being made by his numerous friends and pupils to celebrate that interesting anniversary with appropriate pomp and circumstance. A committee has been formed for the purpose of collecting subscriptions, to be applied to the development of the Rudolf Virchow Stiftung, which was established for the furtherance of science in 1881. The president of the committee is Prof. Waldeyer, the distinguished anatomist of Berlin; the secretary is Prof. Posner.

THE committee appointed by the International Congress of Geologists in August last has, says *Science*, announced as the subject proposed for the Spendiaroff prize for 1903 "A Critical Review of the Methods of Classification of Rocks" (Revue critique des méthodes de classification des roches). The value of the prize is 456 roubles, or about 64*l*. Manuscripts should be addressed to M. Charles Barrois, secrétaire général du Congrès Géologique International, 62, Boulevard Saint Michel, Paris. At least two copies of papers submitted in competition are required, and they should be sent, at the latest, a year before the next session of the Congress in 1903.

THE erection of a memorial to the late Prof. Huxley in Ealing, where he was born and received his early education, is contemplated. On the initiative of the council of the Ealing Natural Science Society, a committee of those persons connected with the district who are interested in the project has been formed. The first meeting of this committee was held on March 29, when an executive committee was appointed with the Rev. Prof. G. Henslow as chairman. A bronze medallion portrait has been advocated for the central feature of the design, which may take the form of a simple mural tablet or of a more worthy monument, as funds are obtainable, while should that support be forthcoming for which its projectors hope, an annual grant or medal might also be founded. Subscription to the fund is not confined to residents in Ealing, and persons who may be desirous of assisting in the endeavour to show honour to the memory of Huxley in the place of his birth should communicate with the treasurer of the fund (Mr. T. Simpson, Fennymere, Castle Bar, Ealing), or with the secretary (Mr. B. B. Woodward, 120 The Grove, Ealing).

THE investigation of the Louisiana Gulf Coast, made by Prof. Beyer for the American Ornithological Association for the purpose of stationing wardens to protect the sea birds, shows that action was not taken a moment too soon. Prof. Beyer found that nearly all the breeding places of the birds had been destroyed by killing the birds themselves and taking their eggs. Not a trace of birds was found on either Brush or Caillou Islands, at one time the home of millions of sea fowl. The same was true of Calumet and Castelle Islands, on which every living thing had been killed. A few gulls and hens were found left on Timbalier Island, and there are said to be a few on Last Island, which, however, could not be visited on account of the severe weather. Wardens were appointed wherever birds were found, and the fishermen of the neighbourhood promised to co-operate with the wardens in preventing the killing of the birds in the breeding season and the stealing of eggs.

THE annual general meeting of the Zoological Society was held on Monday. In the report of the council, reference was made to the publication of the fifteenth volume of the Society's *Transactions*, consisting of a monograph of the genus Casuarius, by the Hon. Walter Rothschild. A new pheasantry was built during the past year, and is now tenanted by a full series of members of the pheasant family. The number of visitors to the Gardens in 1900 was 697,178, showing a slight increase over the corresponding number in the previous year. The number of animals living in the Society's Gardens at the end of December last was 2865, of which 758 were mammals, 1495 birds, and 612 reptiles and batrachians. Amongst the additions made during the past year thirty-one were specially commented upon as being of remarkable interest, and in most cases new to the Society's collection. The Duke of Bedford was re-elected president of the Society.

WE learn from the *Electrician* that, in response to the complaints of a number of leading shipping companies, including the White Star, Cunard and American Lines, the Board of Trade has instructed the Marconi Company to erect a signalling station on the mainland close to the Fastnet Rock, at the western extremity of Ireland. All vessels fitted with wireless transmitting apparatus will henceforth be able to report to the shore when many miles outside the Fastnet, and this will, of course, abolish the waste of time and labour caused by the necessity for incoming steamers to pass inside the Fastnet in order to report to Lloyd's station on the mainland.

THE deposits of salt at Salton, California, U.S.A., forms one of the sights of America. They occur in a depressed portion of the Colorado Desert, parts of which are as much as three hundred feet below sea-level. The deposits cover as much as a thousand acres, and the company in possession of the area has shipped from it annually about two thousand tons of salt. The salt is cut by means of a plough and is piled into heaps such as those shown in the accompanying illustration, reproduced from the *Scientific American*. Each plough harvests about seven hundred tons of salt per day. A singular characteristic of the bed is that the salt is being deposited daily by springs which run into the basin, and as the water evaporates it leaves behind a crust of almost pure sodium chloride, which ranges from ten to twenty inches in thickness over the area. Geographers will remember that the deposits occupy part of the area of the desert of California flooded to the extent of hundreds of square miles in 1892, when the Colorado River broke it barriers.

THE origin of coal and the extent to which the coalfields of Great Britain have been worked were the scientific questions dealt with by Mr. E. B. Wethered in his presidential address to the Cotteswold Naturalists' Field Club on April 23. It was pointed out that the extent of our present exportation of coal was not contemplated by the Royal Coal Commission in 1871. In 1867 the amount of coal exported was 10,233,135 tons, and it was thought that no considerable increase would take place, whereas nearly fifty-six million tons were exported in the year 1899, including about twelve million tons consumed by steamers engaged in foreign trade. In the matter of home consumption the Commissioners were remarkably correct, their estimate for 1899 being 162,400,000 tons, the actual figures being 164,284,757 tons. Mr. Wethered suggests that another Commission should be appointed to consider the probable duration of the coalfields. Another point on which information is required is as to what natural stores of coal are under the Secondary rocks, and at what depths. It is of national importance that this information should be obtained.

Symons's Meteorological Magazine for April contains what purports to be the first tables of the climate of Pemba ever published. They were taken by Mr. T. Burtt at Banani, during the years 1899 and 1900. The small island of Pemba forms, with Zanzibar, that portion of the British East Africa Protectorate nominally under the rule of the Sultan of Zanzibar, the position of Banani being approximately 5° 15′ S., 39° 43′ E. The temperature is of course very uniform, the mean of the monthly maxima being 83°·4 and of the minima 70°·8, the absolute maximum being 95° and the minimum 65°. The rainfall is copious, averaging about 98 inches. The two rainy seasons are well marked, the greater being March to May, and the less November to January.

MR. G. W. KIRKALDY has favoured us with a copy of his paper on the stridulating organs of water-bugs, recently published in the *Journal* of the Quekett Microscopical Club. The males of these insects, which alone produce the sounds, can mostly be referred to their proper species from the stridulating organs alone. Generally it seems that the sound is produced by drawing the comb-like structure situated on the tarsus of one leg across the femur of the other, and *vice versâ*. But it is believed that there is also a second musical area, one of the constituents, at least, of which is situated on the abdomen. Observations are needed as to the precise *modus operandi* of both types of stridulating organs in these insects.

THE *Biologisches Centralblatt* of April 1 contains the two concluding sections of Dr. C. Rengel's account of the life-history of the great black water-beetle commonly known as *Hydrophilus piceus*. It is shown that, unlike those of the brown water-beetles (*Dytiscus*), which devour free-swimming creatures like tadpoles and the larvæ of other insects, the larvæ of the black water-beetle subsists on slow-moving organisms, especially pond-snails. In the earlier stages of their existence the larvæ devote their attention to Physa and the smaller kinds of Lymnæa, but when full grown they do not hesitate to attack the comparatively large *Planorbis corneus*. The idea that these larvæ always seek a hole in the ground in which to pupate is shown to be incorrect, the transformation having been observed to take place among a mass of weeds. It seems also that when a hole is selected, this is not excavated by the larvæ themselves. By an inadvertence the title of this paper occurs in the table of contents of the *Centralblatt* of April 15.

THE issue of the *Revue Scientifique* of April 20 contains the first instalment of an interesting article by M. Henri Coupin on the song of birds. The author commences by referring to the large proportion of tuneful species met with among the birds of Europe, which he sets at ten per cent., whereas in the tropics it falls as low as one per thousand. The gorgeous birds of the tropics he compares to actresses without talent, who depend for success on the richness of their toilets. Stress is then laid on the fact that, in spite of its simplicity, bird-song cannot be imitated by any known musical instruments. It is possible, indeed, to reproduce the pitch and intensity of the notes, but not the *timbre*, which includes such a multitude of sounds as to defy imitation. Indeed, the observations of M. F. Lescuyer have shown that although the notes of birds correspond to those of our musical scale, yet they also include a number of vibrations occupying the intervals between our notes, and it is this which renders imitation impossible. In most birds the duration of the song is very brief; in the thrush and the chaffinch it lasts only two or three seconds, in the blackcap from four to five seconds, and from two to five minutes in the lark. The author then proceeds to analyse the sounds constituting the songs of birds, and to distinguish between their songs and their alarm-cries.

WE have just received Part vii. of the bibliography of the more important contributions to American economic entomology, issued by the U.S. Department of Agriculture (Division of Entomology), extending from December 31, 1896, to January 1, 1900. This part, prepared under the direction of Prof. L. O. Howard, the entomologist, by his assistant, Mr. Nathan Banks, contains an alphabetical index, under authors' names, of 1383 papers in different American periodicals, and a subject-index extending to thirteen pages (double columns) in small type. The book is a good illustration of the energy with which economic entomology is pursued in the United States, where, however, it must be remembered that insects are much more numerous and destructive than in Europe, or at least in England.

THE issue of *Die Umschau* for April 20 contains a short illustrated article on the ship *Gauss*, which has been built for the German Antarctic Expedition. A photograph from a model and some views of the vessel in various stages of construction are reproduced.

DR. E. FRIEDRICH contributes a paper on the india-rubber production of Africa to the *Deutsche geographische Blätter*. The export statistics of twenty-five African colonies are dealt with, and the results exhibited graphically on a sketch-map, from which some interesting geographical conclusions are drawn.

THE *Verhandlungen* of the Berlin *Gesellschaft für Erdkunde* contain a brief abstract of a lecture, by Dr. K. Kretschmer, on the physical development of the North Sea coasts during historic times. The author refers specially to the regions near the mouths of the rivers Ems and Jade, and describes changes recorded by various authorities since Roman times.

WITH reference to Mr. T. W. Kingsmill's letter in last week's issue (p. 608), Prof. Haddon writes to say that he appreciates its value, but at the same time he wishes to disclaim any first-hand knowledge of Chinese authorities, and to remark that in his article he merely gave an account of M. Ujfalvy's views.

A VOLUME on the history of physiology during the sixteenth, seventeenth and eighteenth centuries, by Sir Michael Foster, will shortly be published in the Cambridge University Press Biological Series, edited by Mr. A. E. Shipley. The book will consist of lectures delivered by the author last autumn before the Cooper Medical College in San Francisco. Without claiming to be a complete history of the subject the book will contain a full account of the chief advances made in physiology from the time of Vesalius until the beginning of the nineteenth century. In the same series Prof. Marshall Ward is issuing a work on grasses on a somewhat novel plan. It is essentially a practical book, to be used in the field and in the laboratory, and should be of use, not only to the botanist, but also to the farmer and the gardener.

WE have received from Messrs. A. E. Staley and Co. a catalogue of microscopes manufactured by the well-known Bausch and Lomb Optical Co. of Rochester, New York, U.S.A. From the description of their works contained in the catalogue it is evident that the method of production is essentially American. Machine tools of the most modern description and specialisation of the manufacture of component parts should result in every article being of the highest class. The instruments listed of the so-called "Continental" type do not call for special notice. Of the cheap stands, the American type microscope (F.) is undoubtedly of good design. The horse-shoe foot is replaced by one of a much more stable tripod form, and the arm carrying the tubes and adjustments is particularly well made, giving freedom all round the stage while securing a firm support for the body-tube. All the usual microscope accessories are listed, but there is nothing of such special design as to call for particular notice.

THE additions to the Zoological Society's Gardens during the past week include two Wild Swine (*Sus scrofa*, ♂ ♀), European, presented by H.M. the King; a Leopard (*Felis pardus*) from West Africa, presented by Captain Guy Burrows; an Eland (*Orias canna*, ♂) from South Africa, presented by the Duke of Bedford; two Grey-breasted Parrakeets (*Myopsittacus monachus*) from Monte Video, presented by Mrs. Brownrigg; two Ground Snakes (*Typhlops exocoeti*) from Christmas Island, presented by Sir John Murray, K.C.B., F.R.S.; a Grey-cheeked Mangabey (*Cercocebus albigena*) from West Africa, a Brazilian Tree Porcupine (*Sphingurus prehensilis*) from South America, two Black Tortoises (*Testudo nigra*) from the Galapagos Islands, three Dark Green Snakes (*Zamenis gemonensis*), two Smooth Snakes (*Coronella austriaca*), European, deposited; a Sambur Deer (*Cervus aristotelis*, ♂) from India, two Javan Peafowls (*Pavo spicifer*, ♂ ♀) from Java, two Peacock Pheasants (*Polyplectron chinquis*, ♂ ♀) from British Burmah, two Australian Sacred Ibises (*Ibis strictipennis*) from Australia, two Summer Ducks (*Æx sponsa* ♂ ♀) from North America, two Blood-breasted Pigeons (*Phlogaenas luzonica*) from the Philippine Islands, four Ruffs (*Machetes pugnax*, ♂ ♂, ♀ ♀), twelve Green Lizards (*Lacerta viridis*), European, purchased.

OUR ASTRONOMICAL COLUMN.

COMET a (1901).—The Sydney correspondent of the *Times* reports that a brilliant comet was seen early on Tuesday morning (April 23) at various stations throughout the Australian continent. It was stated to have been near the star Aldebaran (α Tauri).

On Friday, the 26th ult., a telegram received from Dr. Gill announced that the new comet had been observed from the Cape Observatory. It was very brilliant, having a compound triple tail about 10° long. The comet was observed on the eastern horizon some two hours before sunrise and was rapidly approaching the sun, so that it may be expected to become more brilliant as perihelion is passed. It was seen by the observers at the Yerkes Observatory at Wisconsin early on Saturday morning last, about 15° north of the sun. This indicated that it had made a very rapid north-westerly movement in relation to its position when seen at the Cape. It was visible for fully twenty minutes before sunrise and about fifteen minutes after, and is considered the brightest comet seen for the last nineteen years. No account has yet been received of the comet having been seen in this country.

THE APRIL METEORS OF 1901.

A SERIES of very clear nights enabled these objects to be looked for in favourable circumstances this year. Moreover, the moon was absent, so that the smaller class of meteors could be well seen projected on the dark blue of the cloudless sky. Meteors are usually very rare in April, and it is only the shower of Lyrids, occurring in past years on about the 20th, that has made the month interesting to meteoric observers. The display apparently returns annually, but it is often inconspicuous and rarely proves as rich as the August Perseids.

On April 13, 17, 18 and 19 I maintained a watch of the north-east region of sky, but found meteors scarce and there were very few Lyrids. The minor showers of the epoch gave little sign of their presence; in fact, meteoric apparitions were so few and far between that observers found their patience sorely tested. Prof. Herschel watched perseveringly at Slough on the nights of April 10, 13, 14, 15, 16 and 17, and, in the aggregate, only recorded twenty meteors in 8½ hours.

On April 20 at Bristol the sky was brilliantly clear, and I kept a look-out during about five hours of the period from 9h. 50m. to 15h. 30m, but observed only twenty-nine meteors. Not a single Lyrid was included amongst them, though several bright, swift-moving meteors fell from a bordering radiant at 261° + 36° in Hercules.

On April 21 the firmament was less favourable, but soon after commencing to watch at 9h. 45m. I found meteors extremely numerous. Several of the minor showers were very active, and the Lyrids formed a pretty rich display. During 3¼ hours' watching, up to 14h. (allowing for occasional interruptions by clouds), I counted fifty-two meteors, and of these there were twenty-five Lyrids from a radiant about 5 degrees in diameter with 270° + 33° as a centre. But while registering the observed paths of the meteors seen, many others must have eluded detection. The horary rate of meteoric apparitions for a continuous watch of the firmament by one observer would have been about 25 and the proportion of Lyrids 12. The figures represent rather an unusual display, though falling far short of the strength of the Perseids and some other periodical showers. It must be remembered, however, that at the epoch of the Lyrids meteors are generally very rare, and that the principal shower is itself sometimes very feeble, if not quite invisible.

The fact of the maximum being so definitely marked on April 21, while there was a comparative absence of Lyrids on April 19 and 20, shows that for some time in future we must expect these meteors on the former date. This is, no doubt, owing to 1900 not having been a leap year. And the shower appears to be a very fugitive, short-lived one, or it must have exhibited more decided traces on April 19 and 20. Though I saw no Lyrids whatever at Bristol on April 20, Prof. Herschel informs me that he observed 5 during the night.

Nearly all the Lyrids seen this year were accompanied with streaks; this feature was, indeed, as well shown as it usually is in the case of the Perseids, Orionids and Leonids. When the radiant was rather low on April 21, the apparent motions were estimated as slow and slowish; but in the later hours of the night, with increasing altitude of the radiant, the velocity appeared much swifter.

Some of the meteors from Lyra and other constellations were very interesting, and in the following list I have made a few selections in the hope that the objects may have been observed elsewhere, and that the requisite data may be obtained for computing their real paths in the air.

	h.	m.	Mag.	From °	°	To °	°	
April 21 ...	10	9	♃ ...	278½	+52 ...	304	+70	Lyrid
	10	41	3 ...	202	+40 ...	213½	+ 7	α-β Perseid
	10	50	2 ...	210	+50 ...	171	+40	Lyrid
	10	59	2 ...	218	+52 ...	255	+75	Virginid
	11	23	1 ...	70	+57 ...	88	+50	Cassiopeid
	12	47	2 ...	269	+46 ...	305	+49	Virginid
	13	7	♃ ...	242	+74 ...	130	+74	Lyrid

On April 20, at 10h. 35m., I noticed a brilliant double flash, caused probably by a large meteor at a low altitude, and hidden from my view by houses in this locality.

Two meteors appearing on April 18 were mutually observed at Slough and Bristol. The first was seen at 13h. 19m., and it fell from an altitude of 83 to 55 miles over Oxfordshire. The radiant was at 266° + 33°, so the meteor was an early Lyrid, and it having been well seen at both stations, the direction of its flight was recorded with considerable accuracy. The position of its radiant at 266° + 33°, as compared with the general Lyrid centre at 270° + 33° three nights later, on April 21, proves that this shower, like that of the August Perseids, exhibits a radiant moving eastwards at the rate of about one degree per day. The second meteor doubly observed was registered at 14h. 47m., and it descended from 58 to 44 miles over the borders of Gloucestershire and Oxfordshire. The radiant was at 247° ± 0°, so the meteor belonged to one of the minor showers of the epoch.

Since writing the above I have learnt that two bright meteors, the 1st and 5th in the above list, were observed by Mr. C. L. Brook at Meltham, near Huddersfield, as well as at Bristol. The first was a Lyrid with radiant at 268° + 30°, and it fell from 79 to 54 miles in height over the Midlands. Its length of path was 60 miles and velocity 40 miles per second. The other meteor was a Cassiopeid belonging to a radiant at 21° + 59°, and falling from 66 to 44 miles over Merioneth and Cardigan, Wales. Its observed length of path was 55 miles and velocity 14 miles per second. It is remarkable that though few, if any, of the smaller class of shooting stars diverge from this radiant near δ Cassiopeiæ in the spring months it yet furnishes many fireballs. In the General Catalogue of Radiants, No. xv. p. 228, the radiants of five fireballs appearing in April and May give a mean centre at $20° + 57°$, which is almost identical with that of the bolide of April 21 last. W. F. Denning.

CHEMISTRY IN ITS RELATIONS TO ENGINEERING.[1]

The engineer of fifty years ago can hardly be said to have received any special educational training; he forced himself to the front in virtue of his qualities and industry alone. But the youth who to-day intends to become an engineer feels it wise, if not necessary, to decide where he shall receive, not only his general, but also his engineering education. While he was at school he will have learnt much about the simpler and more general laws and facts of mechanics and natural science, both by description and by practical work in the laboratory and in the workshop; he will also have attained to some proficiency in mathematics, in one or more of the modern languages, in drawing and in other usual school subjects. When he passes on to his college career his knowledge of these subjects will undergo expansion in the class-room and especially in the laboratory and workshop. It is satisfactory to find that many of our leading schools for training engineers exist in connection with institutions in which pure and applied mathematics, natural science and modern languages are efficiently taught even in their higher stages. The engineering student is thus afforded the opportunity of following up the higher study of any one of these subjects, if his taste and energy lead him to wish him to do so. But even his ordinary course of instruction always includes the opportunity of obtaining lecture and laboratory instruction in chemistry.

Chemistry in Engineering Education.

It appears to be the general feeling of those who have had experience in teaching chemistry to engineering students that it is useless to attempt very much in the small amount of time which can be allotted to the subject in the regular curriculum; it is evidently felt, however, that a student who wishes to attain to any considerable proficiency in the subject should be encouraged to join certain additional courses which are included in the ordinary chemical curriculum.

Probably all that can be expected of the average engineering student is that he shall become generally conversant, during his college course, with chemical language, with chemical principles and laws, and with the chemical nature of the materials with which he has to deal; and that he should obtain such an insight into chemical analysis as to be able to confer with the trained chemist, and to understand the meaning of a general statement of the results of chemical analyses bearing on metals, alloys, fuel, lubricants, cements and other materials which are frequently used by the engineer.

It is beyond question that the engineer has too many calls upon his time and energy, both in his training and in his subsequent career, to allow of his becoming a chemist or a chemical analyst; but he should at least be sufficiently conversant with the science to enable him to appreciate the important bearings of chemistry on his varied requirements, and to enable him to avail himself intelligently of the results of chemical investigation and analysis. He should be able to watch and to appreciate any chemical inquiry and investigation, even if he is not qualified to suggest its methods of procedure or to carry it out himself.

It has been stated to me by a German manager of large English works, who has frequently occasion to call in the professional advice and assistance of both engineers and chemists, and who is himself well educated in both departments, that he has to lament in this country the "absence of useful engineering knowledge among chemists, and of useful chemical knowledge among engineers." Another informant states that Germany employs many more trained chemists working in conjunction with her engineers than England does.

Applications of Chemistry to Engineering.

In order to illustrate some of the advantages which engineers have derived from chemical coadjutors, one or two instances may be selected from different fields of engineering activity and enterprise.

In the matter of supplying the engineer with suitable constructive materials, the most striking case is that of the introduction of cheap steel of varying qualities in substitution for costly steel and other less suitable forms of iron.

The Bessemer process owed its original suggestion, as well as its salvation from failure, to the chemical knowledge which was supplied to those who were interested in the procedure. It further owed the extension of its application to all the commonest, cheapest and most abundant kinds of impure English cast iron to the further utilisation of chemical knowledge and suggestion.

At the present time the metallurgical chemist and the chemical metallurgist are engaged in furnishing metals and alloys, new to commerce, which can rank in importance with cheap steel, only in a somewhat minor degree; and the engineer in every department of his activity is now continually having placed at his disposal alloys which are more suitable for his various designs than any which he has hitherto employed.

It is scarcely necessary to point out the absolute necessity of chemical knowledge and chemical advice to the gas engineer. In the matter of water supply, also, both the engineer and the chemist find their respective but closely connected spheres of duty.

There is another direction in which the constant relation of chemistry to engineering, and in which the association of the chemist with the engineer must be maintained, if success is to be secured and expensive failures are to be avoided.

In no application of chemical and engineering principles is the co-operation of chemist and engineer more necessary for the attainment of success than in securing the suitable purification of our town sewage. Such co-operation has enabled London, Manchester and other large centres of population in recent years to carry out on an experimental scale most important trials of the natural or bacterial treatment of sewage, and has led to reports on this method being published which will probably become classical. This experimental work has led to considerable and valuable development and improvement of the bacterial method. There is now no doubt that this process can inexpensively dispose of a large proportion of the putrescible sediment or sewage-sludge, and can render the effluent, not only non-putrescible and suitable for maintaining the life of fish, but even pure if necessary. The process is therefore destined to effect great reforms in our sewage-disposal problem and considerable improvements in the condition of our watercourses.

[1] Abstract of the "James Forrest" lecture delivered at the Institution of Civil Engineers on April 25 by Prof. Frank Clowes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The Rede Lecturer for the present year is Dr. F. W. Maitland, Downing professor of law. Dr. Haddon, F.R.S., gives this term a course of lectures on studies in Papuan ethnology and the races of Oceania, on Mondays and Fridays at 2.30 p.m.

The Medical School Buildings Syndicate recommend the acceptance of tenders for the erection of the Downing Street wing and the Humphry Museum, amounting to more than 26,000*l.*

The Frank Smart studentship in botany at Caius College, of the annual value of 100*l.*, will be vacant at Michaelmas. Candidates must have taken honours in Part i. of the Natural Sciences Tripos. Further information may be had from the senior tutor of the College.

A meeting was held in St. John's College on April 27 for the purpose of procuring a portrait of Prof. Liveing, F.R.S., as a memorial of his lifelong services to the University. The meeting was largely attended by members of the Senate, and a warm tribute was paid to the professor, who began his teaching of chemistry fifty years ago, and who during that time has in many ways, public and private, benefited the University, town, and county of Cambridge. A strong committee was formed to carry out the purpose of the meeting.

Prof. Newton announces that there are vacancies for workers at the University tables in the Plymouth and the Naples zoological stations. Applications are to be sent to him by May 23.

Twenty-one candidates have passed the half-yearly examination in sanitary science for the diploma in Public Health, held in April.

Dr. J. N. Langley, F.R.S., is re-appointed deputy-professor of physiology until Michaelmas 1903, in the place of Sir M. Foster, M.P.

MR. R. T. SMITH has been appointed principal of the Northern Polytechnic Institute. He organised and equipped the South African College, Capetown, and acted as professor of mathematics and physics in the College for several years; and, more recently, was lecturer in mathematics and physics in the Goldsmiths' Institute, New Cross.

THE Secretary of State for War has appointed a committee to consider the education of candidates for commissions in the Army and the system of training at Woolwich and Sandhurst, and to report whether any changes are desirable in the present methods of entrance into the Army. The following will form the committee:—The Right Hon. A. Akers-Douglas, M.P. (chairman); the Rev. Dr. Warre, headmaster of Eton; Mr. F. W. Walker, high master of St. Paul's School, Hammersmith; Colonel Jelf, C.M.G., Royal Engineers; Lieutenant-Colonel Hammersley, Lancashire Fusiliers; Captain Lee, M.P., late professor of strategy and tactics, Royal Military College, Canada; and Captain W. E. Cairnes, Royal Irish Fusiliers (secretary).

ADVOCATES of improvements in geometrical teaching will be glad to know that the Civil Service Commission has lately introduced a change of importance to all who are concerned with Civil Service examinations. Before this year an instruction at the head of examination papers in geometry stated that "Proofs other than Euclid's must not violate Euclid's sequence of propositions." Upon recent papers, however, this has been superseded by the note that "Correct demonstrations, whether those of Euclid or not, will be accepted." It thus becomes possible for teachers preparing pupils for the Civil Service to be independent of Euclid's sequence or proofs. Recent questions also encourage teaching of a less abstract character than that usually associated with Euclid's geometry. We understand that the Board of Education will accept alternative proofs of propositions in future examinations in geometry.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, April 26.—Dr. R. T. Glazebrook, foreign secretary, in the chair.—A paper on the thermodynamical correction of the gas thermometer was read by Prof. H. L. Callendar. This paper commences by giving a short historical sketch of the thermodynamic correction of the gas thermometer, describing some of the solutions to Thomson's fundamental equation for the Joule-Thomson plug experiment. The assumptions made in the solutions have sometimes been erroneous and wrong corrections have been obtained. From 1885 to 1888 Chappuis made a series of careful comparisons between various gas thermometers and a very delicate mercury thermometer, and drew up a table of differences between the hydrogen and the nitrogen thermometer. The author has taken the observations of Chappuis and calculated a new table of differences. The index "n" in the modified Joule-Thomson equation is not constant. For steam it is about 3·5 and for carbonic acid about 2. The thermodynamic correction is very small, especially in the case of hydrogen and helium, and is very much less than the correction for the expansion of the thermometer bulb. Prof. Herschell asked whether the co-volume came into the correction. Dr. Harker looked forward to the experiments which Prof. Callendar proposes to make with a constant pressure thermometer. The chairman expressed his interest in the extreme delicacy of the observations of Chappuis.—A paper on the production of a bright-line spectrum by anomalous dispersion and its application, the "flash-spectrum," by R. W. Wood, was read and experimentally illustrated by Mr. Watson. It has been suggested by W. H. Julius that the "flash-spectrum seen immediately at totality may be due to photosphere light abnormally refracted in the atmosphere of metallic vapours surrounding the sun. The light which will be thus abnormally refracted will be of wave-lengths almost identical with the wave-lengths which the metallic vapours are themselves capable of radiating. The sun is supposed to be surrounded by an atmosphere of metallic vapours, the refractive index of which decreases with increasing distance from the surface. In this atmosphere the rays of light coming from the photosphere move in curved paths. The refractive index is, however, very small, except for wave-lengths very near those absorbed by the vapour, consequently the light which resembles that emitted by the vapours, is most strongly refracted, and therefore curves sufficiently to reach us after the photosphere has been hidden by the moon. The flash-spectrum of sodium was shown by focussing the light of an arc lamp on a horizontal slit in front of a flat metal plate supported so that the plane in which its under-surface lay coincided with the plane of the slit. At a distance of about two metres a direct vision spectroscope was arranged to give a vertical spectrum and placed at such a height that the prism barely caught the rays coming from the slit and grazing the plate. On looking into the spectroscope a bright continuous spectrum is seen. A Bunsen burner was then placed underneath the metal plate and fed with sodium. This produced a layer of sodium vapour of varying refractive index. On raising or lowering the spectroscope bright sodium lines are seen due to anomalous dispersion. By arranging screens these lines can be obtained so that, on cutting out the arc lamp, the flash-spectrum vanishes. Prof. Herschel expressed his interest in the experiments and their application to the case of the flash-spectrum seen at totality.

PARIS.

Academy of Sciences, April 22.—M. Fouqué in the chair.—On the residues and periods of double integrals of rational functions, by M. Émile Picard.—On an apparatus designed to move the photographic plate which received the image furnished by a siderostat, by M. G. Lippman. In an image given by a siderostat only one point is really fixed, the other points appearing to move round this with a variable velocity. It is shown that a suitable motion can be given to the photographic plate capable of overcoming this defect by means of a gear driven by the clockwork of the siderostat.—On the existence of nitrides, argonides, arsenides and iodides in crystalline rocks, by M. Armand Gautier. The finely powdered granites and basalts were decomposed by heating at 100° with phosphoric acid. Determinations are given of the amount of nitrogen, arsenic and iodine in various rocks.—Comparison of the work done by a muscle in sustaining and lifting a charge, by M. A. Chauveau.—On the propagation of discontinuities in a viscous fluid; extension of the law of Hugoniot, by M. P. Duhem.—On a question relating to a displacement of a figure of invariable size, by M. R. Bricard.—On entire functions of several variables and their modes of growth, by M. Émile Borel.—Some isotherms of ether between 100° and 206°, by M. Edouard Mack. The pressure of the ether vapour was balanced by a piston floating on a very viscous liquid, and the volume of the ether, which was completely surrounded by a mercury bath, was deduced from the motion of the piston.—Cryoscopic researches, by M. Paul Chroustchoff. An account of some of the precautions necessary in applying the platinum thermometer to the measurement of the lowering of the freezing-point of dilute solutions.—On a new system of ammeters and voltmeters independent of the intensity of their permanent magnets, by M. Pierre Weiss. In an instrument of the d'Arsonval type a decrease in the strength of the permanent magnet causes a decrease in the sensibility of the instrument; in instruments having a movable magnetic needle controlled by a permanent magnet the opposite is the case. If, in an instrument of the moving coil type, the coil carries a small piece of soft iron, these two effects may be made self-compensating. It was found possible to construct a galvanometer of this type in which the sensibility was practically invariable.—On the influence of self-induction upon spark spectra, by Mr. G. A. Hemsalech. Three photographs are given showing the progressive changes produced in the spark spectra of cobalt, lead and magnesium by an alteration in the self-induction of the spark circuit.—Periodic oscillations productions by the superposition of an alternating current on a continuous current in an electric arc, by M. E. Kœnig.—On an apparatus which imitates the effect of luminous fountains, by M. G. Trouvé.—On barium hydride, by M. Guntz. Barium hydride, the existence of which was first indicated by Winkler, has been obtained in a pure state and found to have the composition BaH_2. This compound is of remarkable stability; it can be slowly sublimed in a current of hydrogen at 1400° C. without decomposition. Heated in a current of nitrogen, barium nitride is formed.—The estimation of nitric acid in waters by means of stannous chloride, by M. H. Henriet. The fact discovered by Divers and Haga that nitrates react with stannous chloride giving hydroxylamine chloride has been applied by the author to the quantitative determination of nitrates in potable waters.—The action of various alcohols upon some acetals of monovalent alcohols, by M. Marcel Delépine. — On three new alkaloids from tobacco, by MM. Amé Pictet and A. Rotschy. Further particulars of the physical and chemical properties of the three alkaloids nicoteine, nicotimine and nicotelline.—The action of phenylhydrazine and of hydrazine upon the two isomeric methyl butyrylacetylacetates, by M. Bongert. On paraoxyhydratropic acid, by M. J. Bougault.—Some new reactions of organometallic derivatives, by M. E. E. Blaise.—On a new base derived from glucose, by MM. L. Maquenne and E. Roux. The base, which is termed glucamine, is obtained by reducing glucosoxime with sodium amalgam.—Action of the alkylcyanacetic esters on the diazochlorides, by M. G. Favrel.—Reduction of the nitro-derivatives of the azoic colouring matters, by M. A. Rosenstiehl.—On two new acetylenic acids. Synthesis of caprylic and pelargonic acids, by MM. Ch. Moureu and R. Delange.—On the indoxylic origin of certain red colouring matters of urine, by M. L. Maillard.—The calculation of the results of milk analyses, by MM. Louise and Riquier.—Segmentation in the genus Trochus, by M. A. Robert.—Action of isotonic solutions of chlorides and of sugar on the eggs of *Rana fusca*, by Mme. Ronfeau-Luzeau.—The stimulation of nerve and muscle by waves of very short duration, by M. G. Weiss.—Action of alcohol upon the gastric secretion, by MM. Albert Frouin and M. Molinier. The increased secretion of the gastric juice caused by alcohol is shown experimentally not to be due, as has been usually supposed, to a direct local action, nor is it due to an effect produced upon the nerves of taste.—On the second fermentation of the wines of Champagne, by M. E. Manceau.—Apparatus for the exact measurement of the skeleton and of other organs giving a clear image in radiography, by M. G. Contremoulins.—On the origin and mode of formation of the Oolitic iron ore of Lorraine, by M. Stanislaus Meunier.

DIARY OF SOCIETIES.

THURSDAY, May 2.

Royal Society, at 4.30.—On the Variation in Gradation of a Developed Photographic Image when impressed by Monochromatic Light of Different Wave Lengths: Sir W. de W. Abney, F.R.S.—Ellipsoidal Harmonic Analysis: Prof. G. H. Darwin, F.R.S.—On the Small Vertical Movements of a Stone laid on the Surface of the Ground: Horace Darwin.—On the Intimate Structure of Crystals. Part V. Cubic Crystals with Octahedral Cleavage; Prof. W. J. Sollas, F.R.S.

Linnean Society, at 8.—Studies in Heterogenesis: Prof. H. C. Bastian, F.R.S.

Chemical Society, at 8.—The Synthetical Formation of Bridged-Rings. Part I. Some Derivatives of Bicyclopentane: Prof. W. H. Perkin, jun., F.R.S., and Dr. J. F. Thorpe.—Ballot for the Election of Fellows.

Institution of Electrical Engineers, at 8.—An Instrument for Measuring the Permeability of Iron and Steel: C. G. Lamb and Miles Walker.—A Watt-Hour Meter: Frank Holden.

Röntgen Society, at 8.—Some X-Ray Improvements: James Cadett.

FRIDAY, May 3.

Royal Institution, at 9.—Memory: C. Mercier.

Society of Arts, at 8.—Polyphase Electric Working: A. C. Eborall.

Anatomical Society, at 4.—(*a*) Additional Notes on the Articulations between the Occipital Bone, Atlas, and Axis in the Mammalia: (*b*) On the Development of Digits in Cetacea; (*c*) Observations on the Development of the Human Brain before and after Birth: Prof. Symington.—A Contribution to the Study of the Morphology of Adipose Tissue: Dr. H. Batty Shaw.—A Lantern Demonstration showing the Origin and Nature of the Hydatiform Bodies of the Testicle and Broad Ligament, with Special Reference to the Fate of the Mullerian Duct in the Epididymis: J. H. Watson.—Relation of Structure to Function, as illustrated by the Growth of the Inferior Femoral Epiphysis: Prof. Arthur Thomson.

Geologists' Association, at 8.—Geology and the Growth of London: A. Morley Davies.

SATURDAY, May 4.

Royal Institution, at 3.—Climate: its Causes and its Effects: J. Y. Buchanan, F.R.S.

MONDAY, May 6.

Society of Arts, at 8.—Alloys: Sir W. C. Roberts-Austen, K.C.B., F.R.S.

TUESDAY, May 7.

Royal Institution, at 3.—Cellular Physiology: Dr. A. Macfadyen.

Society of Arts, at 4.30.—The Coal Problem—its Relations to the Empire: Lieut. Carlyon W. Bellairs, R.N.

Zoological Society, at 8.30.—On the Spiders of the Family Attidæ found in Jamaica: Mr. G. W. Peckham and Mrs. E. G. Peckham.—On the Hymenoptera collected during the "Skeat Expedition" to the Malay Peninsula, 1899–1900: P. Cameron.—On the Arachnida collected during the "Skeat Expedition" to the Malay Peninsula, 1899–1900: M. Eug. Simon.

WEDNESDAY, May 8.

Society of Arts, at 8.—School Work in Relation to Business: Sir Joshua Fitch.

Geological Society, at 8.—The Influence of the Winds upon Climate during the Pleistocene Epoch: a Palæo-Meteorological Explanation of some Geological Problems: F. W. Harmer.

Iron and Steel Institute, at 10.30.—Annual Meeting.

THURSDAY, May 9.

Royal Society, at 4.30.

Mathematical Society, at 5.30.—(1) A Case of Algebraic Partitionment; (2) On the Series whose Terms are the Cubes and Higher Powers of the Binomial Coefficients: Major MacMahon, R.A., F.R.S.—A Property of Recurring Series: G. B. Mathews, F.R.S.—The Product of Two Spherical Surface Harmonic Functions: J. B. Dale.

Institution of Electrical Engineers, at 8.—Storage Batteries in Electric Power Stations, controlled by Reversible Boosters: J. S. Highfield.

Iron and Steel Institute, at 10.30.—Annual Meeting.

FRIDAY, May 10.

Royal Institution, at 9.—The Response of Inorganic Matter to Mechanical and Electrical Stimulus: Prof. J. C. Bose.

Society of Arts, at 8.—Polyphase Electric Working: Alfred C. Eborall.

Royal Astronomical Society, at 8.

Malacological Society, at 8.

SATURDAY, May 11.

Royal Institution, at 3.—The Rise of Civilisation in Egypt: Prof. W. M. Flinders Petrie.

CONTENTS.

THURSDAY, MAY 9, 1901.

EARLY HISTORY OF THE THERMOMETER.

Evolution of the Thermometer, 1592–1743. By Henry Carrington Bolton. Pp. 98. (Easton, Pa., U.S.A.: Chemical Publishing Co., 1900.) Price 1 dollar.

THIS is a most interesting little book, giving the history of the thermometer from the time of Galileo to that of Celsius and Christin.

Galileo's first instrument is thus described in a letter written by Father Castelli and dated 20th September, 1638, in which he says it was used in public lectures 35 years before. "Galileo took a glass vessel about the size of a hen's egg, fitted to a tube the width of a straw and about two spans long; he heated the glass bulb in his hands and turned the glass upside down so that the tube dipped in water held in another vessel; as soon as the ball cooled down the water rose in the tube to the height of a span above the level in the vessel; this instrument he used to investigate degrees of heat and cold."

According to Viviani, author of a "Life of Galileo," published in 1718, this instrument was invented about the time he became professor of mathematics in Padua; this was towards the end of 1592.

Sanctorius, a medical colleague of Galileo, appears to have appreciated the value of fixed points for graduation, and for this purpose he used snow and the heat of a candle; the range thus obtained he divided into degrees. The thermometer was applied by him to take the temperature of the human body; in one instrument the bulb was constructed so as to go into the patient's mouth.

Sanctorius, in his "Commentaries on Galen," speaks of the thermometer "as a most ancient instrument," and it has been suggested by Cleveland Abbe that the instrument was known before the time of Galileo and that his work consisted in the addition of a scale.

The first sealed thermometer was made some time prior to 1654 by Ferdinand II., Grand Duke of Tuscany; he filled the bulb and part of the tube with alcohol, and then sealed the tube by melting the glass tip. Ferdinand and his brother, Leopold de Medici, promoted the establishment in Florence of the Accademia del Cimento, and the accounts of their experiments, published in 1667 and translated into English by Waller in 1684, contain descriptions of various thermometers made and used by the members. One of these old thermometers was given by the Grand Duke of Tuscany to the late Prof. Babbage, and is now in the Cavendish Laboratory at Cambridge.

In England about the same time Boyle made experiments on thermometers. His "Lectures on Cold" were published in 1665 in obedience to the command of the Royal Society, "imposed on me in such a way that I thought it would less misbecome me to obey it unskilfully than not at all. Especially since from so illustrious a company (where I have the happiness not to be hated) I may, in my endeavours to obey and serve them, hope to find my failings both pardoned and made occasions of discovering the truths I aimed at."

The second discourse of these lectures contains some "New Observations about the Deficiencies of Weather Glasses, together with some considerations touching the New or Hermetical Thermometers."

Boyle felt the need of fixed points. Hooke, in his "Micrographia," describes some thermometers with stems above four feet long, in which the range between summer and winter was nearly the length of the stem. To graduate the stems he placed zero at the point where the liquid stood when the bulb was in freezing distilled water; thus to him belongs the credit of taking the temperature of the freezing point of water as the lower fixed point.

There appears to be considerable doubt as to who first employed mercury as the thermometric liquid; the Accademia del Cimento used such an instrument in 1657, and they were known in Paris in 1659. Fahrenheit, however, appears to have been the first to construct, in 1714, mercury thermometers having trustworthy scales.

The use of the boiling point of water as the upper fixed point was suggested by Carlo Renaldini in 1694, who published, at the age of eighty years, a work on natural philosophy.

Sir Isaac Newton, in his "Scala Graduorum," published in the *Phil. Trans.* in 1701, adopts linseed oil as the thermometric liquid. He took as the fixed points the melting point of ice and the temperature of the human body, calling the one 0° and the other 12°. On this scale he gives as the boiling point of water 34°, and as the melting point of lead 96°. Newton did not adopt the boiling point of water as a fixed point.

After an interesting reference to Amontons and others who worked at thermometry in the latter part of the seventeenth century, Mr. Bolton describes the labours of Fahrenheit, who was born in 1686. His work began in 1706. His skill as a glass worker was very great and enabled him to carry out many designs. In his own account of the instrument he says: "The scale of the thermometers used for meteorological observations begins below with 0° and ends with 96°. The division of the scale depends upon three fixed points, which are obtained in the following manner. The first point below at the beginning of the scale was found by a mixture of ice water and sal ammoniac or also sea salt; when a thermometer is put in such a mixture the liquid falls until it reaches a point designated as zero . . . . The second point is obtained when water and ice are mixed without the salts named; when a thermometer is put into this mixture the liquid stands at 32°, and this I call the commencement of freezing . . . . The third point is at 96°. The alcohol"—it is expressly stated earlier that the thermometers were of two kinds, the one containing alcohol, the other mercury—"expands to this height when the thermometer is placed in the mouth or in the armpit of a healthy man and held there until it acquires the temperature of the body."

Above this temperature the scale was merely lengthened by dividing the tube into equal spaces; one of the divisions marked 212° on a certain thermometer was observed to coincide with the boiling point of water, thus the division of the fundamental interval between the freezing point and boiling point into 180 parts was accidental. If we take these two temperatures as our points of departure, marking them as 32° and 212°, the normal temperature of the human body is 98°·4, not 96°

as on Fahrenheit's original scale, so that the scale now known by his name differs slightly from that originally defined by him. Two of his original instruments are in the Physical Laboratory at Leyden; the freezing points as now given by them are at 34°·2 and 34°·1 respectively; both of these are mercury thermometers.

After Fahrenheit's time came various imitators, each with his own special scale; for an account of them we must refer the reader to Mr. Bolton's pages. Among them the scales of Réaumur and of Celsius alone survive, though, as Mr. Bolton points out, Celsius proposed to call the boiling point of water 0° and its freezing point 100°; the change to the present centigrade scale was made independently in 1743 by Christin, of Lyons, and seven years later by Strömer, a colleague of Celsius at Upsala.

Réaumur's choice of 80° for the temperature of steam was made as a result of his experiments on the expansion of alcohol. He found that alcohol, diluted with one-fifth water, expanded in volume from 1000 to 1080 when raised from the freezing point to the boiling point.

Mr. Bolton is to be congratulated on his work. He has made it most interesting, and it deserves many readers; it suggests the hope that some one may take up similarly the history of other physical instruments and write about them in as bright and capable a manner.

THE OXFORD TEXT-BOOK OF ZOOLOGY.

A Treatise on Zoology. Edited by E. Ray Lankester Part II. *The Porifera and Coelentera.* By E. A. Minchin, G. H. Fowler and G. C. Bourne. With an introduction by E. Ray Lankester. Pp. x + 405. (London: Adam and Charles Black, 1900.)

THE second part of the "Treatise on Zoology," now appearing under the editorship of Prof. Ray Lankester, contains six chapters, the work of four different authors, graduates of the University of Oxford. An introductory chapter by the editor, on the Enterocœla and Cœlomocœla, deals with the main divisions of the Metazoa; Prof. E. A. Minchin writes on the Sponges; Dr. G. H. Fowler on Hydromedusæ and Scyphomedusæ; and Mr. G. C. Bourne on the Anthozoa and Ctenophora. The high character of the whole work, of which the volume previously published (Part III. Echinoderma) gave promise, is fully established by that now before us, and it can scarcely be doubted that this treatise will, for some time to come, be regarded as the standard English text-book for advanced students of zoology.

The classification of the Metazoa adopted by Prof. Lankester in the introductory chapter is based upon the work of the most recent writers on animal morphology, and differs in several ways from that previously adopted in the text-books. The whole animal kingdom having first been divided into two grades, the Protozoa and the Metazoa, the grade Metazoa is considered as giving rise to two branches, the Parazoa, or Sponges, and the Enterozoa, the latter name being a term previously introduced by Prof. Lankester as a substitute for Haeckel's term Metazoa, but which he now proposes to restrict to the second great division of the Metazoa. The view thus adopted of the position of Sponges in the animal kingdom is that advocated by Minchin in the present work (see p. 158); but, as that author points out, it is one which is by no means accepted, at the present time, by other leading authorities on the morphology of the Porifera.

After this main division of the Metazoa, Prof. Lankester proceeds to divide the Enterozoa into two branches, the Enterocœla, or those in which the sole cavity is the enteron, and the Cœlomocœla, those in which the cœlom is present as an independent second cavity. It is certainly open to doubt whether any advantage is gained by the introduction, in a work of this character, of these new terms to replace the already so widely used Cœlentera (or Cœlenterata) and Cœlomata. Indeed, Prof. Lankester himself appears to regard his new nomenclature as tentatively put forward for the consideration of his fellow morphologists, for it is not even adopted in the present volume. The title-page bears the name Cœlentera, and this is the term used both by Mr. Bourne and Dr. Fowler in their sections of the work, the latter writer making use also of the form Cœlenterata (p. 60), to which the editor of the treatise takes exception.

The remaining portion of the introductory chapter gives, in a clear and interesting manner, an account of the author's views with regard to the cœlom and its relations to the other cavities of the body in the different phyla of the Cœlomata (Cœlomocœla), together with a detailed history of the progress of our knowledge of that organ. The discussion of this subject is noteworthy on account of the particularly clear statement of the author's theory of the body-cavity relations found in the Mollusca and Arthropoda. According to this theory, now termed the theory of Phlebœdesis, the true cœlom is present in these groups in a reduced form, whilst the blood-holding spaces (hæmocœl) are in reality swollen blood-vessels. In support of this view, Benham's work on *Magelona* (*Quart. Journ. Micr. Sci.*, xxxix. 1896) is brought forward. The concluding part of the chapter is of interest from the great importance attached to the recent work of Meyer and of Goodrich on the nephridia and cœlomoducts of the marine Chætopoda, the views of these authors being entirely adopted, notwithstanding the fact that they revolutionise the prevailing ideas on the subject, ideas which owe their origin very largely to Prof. Lankester himself.

Prof. Minchin's section on the Sponges, we have little hesitation in saying, contains the most successful account of an animal group which has yet appeared in this treatise. It is in many ways a model of what such a general account should be, and is certainly the most satisfactory summary of our knowledge of the Porifera which at present exists in any language. It is by no means merely a compilation and discussion of facts already put on record by other authors. Much new matter is here recorded for the first time—notably the account of the development of *Clathrina blanca*—and a large part of the descriptive portions of the chapter is the direct outcome of the author's own observation and experience. Prof. Minchin's work as a histologist, which has shown him to be an expert in the most recent and delicate methods of technique, is well known, but the present article proves him to be at the same time a painstaking and observant outdoor naturalist. That a sponge is a living organism and that each species is specially adapted to the particular set of natural conditions under which it grows are facts which are seldom absent from his mind, and as a consequence there is a freshness and reality about much which he has written that are often absent from the writings of the laboratory and museum worker.

Dr. Fowler's accounts of the Hydromedusæ and Scyphomedusæ are, in our opinion, the least satisfactory portions of the volume. The style is too concentrated and concise to make the writing effective, and intellectual interest has been entirely sacrificed in an attempt to introduce every available fact and to deposit it in a properly labelled compartment. The result resembles the syllabus of an advanced course of lectures on the groups dealt with rather than an intelligible account of those groups.

In the chapters on Anthozoa and Ctenophora, Mr. Bourne presents us with an excellent series of detailed descriptions of particular types, together with a clearly stated and well-marshalled body of facts concerning the groups as a whole. His work will undoubtedly prove of great value to both teachers and students. We, however, fail to find in these two sections that originality of treatment and originality of thought which characterise Prof. Minchin's section on the Porifera.

The whole work is well illustrated, being in this respect a great improvement on the volume of the treatise previously published (Part III. Echinoderma). The figures for which Prof. Minchin and Mr. Bourne are responsible, many of which are original, are specially worthy of praise.

THE GRAPHICAL MENSURATION OF VAULTS.

Il Calcolo Grafico applicato alla Misura delle Volte. Prof. Ernesto Breglia. 5th serie, vol. i. (Atti del Reale Istituto d'Incoraggiamento di Napoli, 1899.)

GRAPHICAL methods are used to a certain extent in the solution of engineering problems, although perhaps their employment is not so extended as their neatness and simplicity merit. In some cases, it is true, where the simplification is great and the application easy, they are used practically to the exclusion of other methods. But in other cases where a graphical treatment would effect almost as great a simplification the methods have never been very generally applied. The reason lies, we think, in the fact that it requires greater ingenuity to treat a problem graphically than analytically. Problems such as occur in practice, even though they may be complicated, can generally be hammered out by analytical means. A good mathematician, no doubt, will be able to find a short cut to the solution, but the engineer, whose ready stock of mathematical knowledge on which he can draw with ease amounts to little more than the algebra he learnt at school and an acquaintance with the principles of the calculus, will be able to work out the solution by dint of determined plodding. With graphical methods it is different. To begin with, the geometrical training which an English engineer receives at school is a hindrance rather than a help, so that when he comes to study graphical systems he finds himself in a region unknown to him and is obliged to disembarrass himself of the Euclidean notions acquired in his youth. We are afraid that the Englishman will never be quite happy in using geometrical methods until the groundwork of his knowledge is laid with some more suitable text-book than Euclid's Elements. In addition to this, with these methods each new problem requires somewhat different treatment; it is hard, and often impossible, to lay down very definitely the lines on which to proceed. The ingenuity which is consequently required can only be obtained, by any except the born mathematician, by the habitual use of the system.

Prof. E. Breglia's paper illustrates what we have been saying. The method that he has worked out for measuring the volumes of arches and vaults is extremely neat. In the simpler cases it is, as is natural, very much easier to follow and apply, and the ease of doing so is such that it should commend itself to all who have need to make such measurements. In the cases of vaults of more complicated shape the method becomes also more complex; artifices have to be used in order to "dodge" the more important difficulties. It is just these artifices that are so difficult to find when a new problem is attacked. To apply Prof. Breglia's method to the determination of the volume of a vault similar in shape to one of those he has examined in the paper before us would be fairly simple, even though the shape might be very complicated; to apply it to the case of a vault of quite a different shape would not be nearly so easy. Prof. Breglia has, however, examined a great variety of cases in a thorough manner, and has thus rendered his paper very valuable.

Prof. Breglia's system has other advantages besides a simplicity which enables the volume of a vault of complicated shape to be found without the use of advanced mathematics. The accuracy can be increased practically at will by varying the number of sections into which the vault is divided; with analytical methods high accuracy is often only attainable by undue complication of the mathematics. We are inclined to think, also, with Prof. Breglia that error is less likely to occur in its use, as should any mistake be made it will show itself directly; but this is an advantage that must not be given too great weight, as graphical methods possess possibilities of error, especially in the interpretation of the results, which are not to be met with in other methods. The system is, however, a very useful one, and the paper is worthy the careful attention of all those interested in the subject.

OUR BOOK SHELF.

Experimental Chemistry. By Lyman C. Newell, Ph.D. Pp. xv + 410. (Boston: Heath and Co., 1900.) Price 5s.

DR. NEWELL has added one more to the already formidable array of elementary science text-books, each of which, according to their respective authors, has been written to supply a long-felt need. In the present instance, the object is to promote the more efficient teaching of chemistry by modern methods; and in writing his book Dr. Newell has been actuated by "a desire to provide a course of study which shall be a judicious combination of the inductive and deductive methods."

We fail to see in what way Dr. Newell's book superior to a hundred others of a similar kind. The ideal that the author has set before him is a very high one, and we should be the last to deprecate any attempts to improve upon modern methods of teaching experimental science. It is obvious that the time at the disposal of the average student is so limited that it would be quite impossible to carry out the logical method consistently, and at the same time cover any but the most elementary parts of the subject; the only question is as to the nature of the compromise.

Dr. Newell has attempted to cover a very wide field, with the result that a large amount of matter has been inserted which is beyond the range of an elementary student and of little use to the more advanced. His method is one that is excellent in theory, but in practice easy to carry to excess. To the title of a treatise on elementary chemistry the book lays no claim; it is nothing more than a guide-book for use in the laboratory, and must be supplemented by others for detailed information; while as a work of educational value it is by no means the most efficient that could be devised. Elementary students, however, will doubtless find portions of it of considerable assistance, for the experiments are carefully described, and the illustrations clear.

The Elements of Darwinism, a Primer. By A. J. Ogilvy. Pp. 160. (London: Jarrold and Sons, 1901.) Price 2*s*. 6*d*.

THE object of this little book is, as the author states in the preface, to give the ordinary non-expert reader an intelligent notion of the theory of natural selection. There is no doubt that there is scope for such a work, for even at the present time it is remarkable how widespread are the ignorance and misapprehension of Darwin's teaching among the general public. Mr. Ogilvy divides the subject into three parts: general statement, consisting of eleven chapters; illustrations, consisting of seven chapters; and a third part consisting of nine chapters. Although keeping fairly well within the limits of Darwin's teaching, the author shows some originality of treatment, and has not slavishly followed the custom so prevalent at one time of simply rearranging the facts collected by our great master and dishing them up as an original contribution to science. Several new illustrations of Darwinian principles are introduced, some of them appropriate and forcible, others less appropriate and in some cases altogether questionable. In the chapter on flight, for example, the author attempts to define two kinds: "Now some birds fly chiefly by muscular, some by nervous power." The condor and the albatross are quoted as examples of the former, and the partridge as an example of the latter. The principles which have governed the author in classifying the contents of the various chapters are not in all cases clear, and a rearrangement might have been made in some instances with advantage. One other very obvious defect is the too facile exposition of evolutionary steps which are at present difficult to understand, and of which the course is confessedly obscure. The kind of reader for whom Mr. Ogilvy has written his book is just the person upon whom such treatment would produce an impression of dogmatic security. In spite of these defects, however, any one previously ignorant of the subject who carefully reads the volume cannot fail to acquire a fairly sound idea of Darwinism, and this is all that the author claims to have had in view. It should be added that the manuscript has been read by Dr. Alfred Russel Wallace, who does not, however, hold himself responsible for all the statements. R. M.

La Betterave à Sucre. Par L. Malpeaux. Pp. 206. (Paris: Mayson and Gauthier-Villars. No date.) Price fr. 2.50.

THIS small volume, one of the series known as "l'Encyclopédie scientifique des Aide-Mémoire," is prefaced by a few general considerations upon the importance of the sugar beet. In the opening chapter the history and the present state of cultivation, as well as the future of the sugar beet, are dealt with. As regards the future it is interesting to note that as the supply already meets or even exceeds the demand, the only hope held out to the cultivator is an increase in the consumption of sugar. The second chapter treats shortly of the production of sugar in the plant. A brief description of the different varieties of beet is followed by a chapter on the production of seed. This is perhaps the most interesting portion of the volume before us. In it the methods of selection, physical, chemical and genealogical, the culture of seed plants and the analysis of the roots are given at some length. Then follow chapters on the influence of climate and soil and manures. The important fact that the beet removes from the soil very little else than carbon, hydrogen and oxygen, and therefore the manures supplied to it benefit the crops which follow, is duly insisted on. Two short chapters on sowing, hoeing and thinning are followed by one on diseases, insect and other pests. Although a number of remedies, such as sprinkling with copper arsenite, &c., are mentioned, proper cultivation is upheld as the most important factor in preventing and overcoming such diseases and insect ravages. The remaining pages are devoted to the harvesting and storage, the marketing, and, in connection therewith, the analysis of the juice and the cost of cultivation.

The illustrations are clearly drawn and the curves showing annual production of roots, &c., are a valuable feature of the book. A bibliography of the subject, in which French authors only are mentioned, is attached. The addition of an index would add to the value of this useful monograph. J. E. M.

Assimiliation chlorophylienne et la Structure des Plantes. By Dr. Ed. Griffon. Pp. 106. (Paris: Georges Carré et C. Naud.) Price 2 francs.

L'Evolution du Pigment. By Dr. G. Bohn. Pp. 96. (Same publishers.) Price 2 francs.

THESE two manuals belong to the biological section of the valuable "Scientia" series, each volume of which contains authoritative descriptions of subjects in which progress is being made.

Dr. Griffon's brochure deals with a subject which has engaged the attention of many physiological botanists. Numerous determinations have been made of the physicochemical properties of chlorophyll; and the experimental methods employed to measure the changes resulting from the action of its functions have been so much improved in recent years that valuable results are frequently obtained. But there is a matter which has almost been left in the background, namely, the influence of the structure of plants on the decomposition of carbon dioxide. It is true that important data have been obtained upon this subject, but they are chiefly from special points of view, and no general conclusions have been reached. Dr. Griffon reviews the work which has been done upon this subject, both as regards plants which naturally differ among themselves in anatomical characters and plants of the same species of which the structural differences are due to varying conditions as regards light, heat, hygrometric state, presence of various mineral salts, &c. A chapter upon the nature and measurement of assimilation in plants precedes this treatment, and one on the principal factors determining the rate at which carbon dioxide is decomposed concludes the book. Dr. Griffon succeeds in presenting a connected account of researches and results of interest to all students of botany.

Dr. Bohn's book opens with a general statement of cell structure, bacteria and pigmentary bodies. He then deals in succession with the constitution and biology of pigments, modifications of pigment in organisms, evolution of pigment in various groups of animals, and utilisation of colour in nature for protective and other purposes.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Scope of the Royal Society.

As a general principle it is not desirable to make the affairs of the Royal Society a subject of public discussion. The question to be submitted to the consideration of the fellows on May 9 is, however, of sufficient general interest to justify an exception.

The notice given has been short, and I am unable to be present. No vote is to be taken. It will, therefore, not be too late to draw attention to some facts which appear to me to have been overlooked.

The starting point of the matter as it is presented to the Society is contained in the following statement:—

"The Society exists for the promotion of Natural Knowledge. The interpretation of the term 'Natural Knowledge,' according to the present practice of the Royal Society, assigns to it a range from Mathematics to the various Biological sciences, and this secures the inclusion of the scientific study of man in his biological relations. It has been argued that this range might be properly increased by the inclusion of the scientific study of man in his reasoning, social and historical relations. It may, indeed, be further contended that the Society should include in its scope all branches of Natural Knowledge which are capable of consecutive and ordered development. Such a test would permit the inclusion of subjects such as Psychology, Economics, Historical Science and Philology in the widest sense of the term, which, under the present practice of the Society, may be deemed excluded, but which, when pursued as they now are by the most capable students, in a scientific spirit and by scientific methods, do fall within the domain of Natural Knowledge. The investigation, for instance, of the phenomena of the origin and variations of human speech, of the beliefs and customs of primitive man, of the production and distribution of wealth, of the laws which govern the development of political societies, is an investigation into natural phenomena in a sense which the progress made in our conceptions of nature during the last two centuries seems to justify."

Now I have always understood—and my impression is confirmed by the highest authority—that admission to the Society is actually open to any one who has promoted Natural Knowledge, in whatever field, by scientific methods. The open door may not have been taken advantage of, but I am not aware that there is the smallest ground for believing that it has ever been closed. What I wish to draw attention to is that though the actual representation of the subjects enumerated above may not have been as full as it might have been, I am unable to agree that they, "under the present practice of the Society, may be deemed excluded." A rather cursory inspection of the names of those who have been fellows, or have been elected during the last twenty years, confirms my opinion. Under Economics I find Heywood, Newmarch, Sir James Caird, Jevons, Palgrave, Sir Robert Giffen, Charles Booth and Shaw-Lefevre. I am under the impression that for the period this is a very fair, if not actually adequate, representation of economic science. Historical Science, I presume, must be taken to include archæology and ethnography, otherwise these will have again to be "deemed excluded." Assuming that this is not so, I find the names of General Pitt-Rivers, Sir Augustus Franks, Canon Greenwell, Tylor, Penrose and, in the list now recommended by the Council, of Arthur Evans. Of Historians, in a restricted sense, I find Dean Stanley and Sir Henry Howorth, and, if Privy Councillors are included, of Bryce and John Morley. And with regard to the class of Privy Councillors, it is to be remarked that although any one is eligible it is apparently rare for any to be elected without something more than mere political qualifications. Philology has been more weakly represented; still, I find the names of the Dean of Canterbury, Alexander Ellis, Sir Henry Rawlinson and Bryan Hodgson. And if Psychology finds its only representative at the moment in Lloyd Morgan, it is, I believe, an open secret that Herbert Spencer might, had he thought fit, have been a fellow of the Society.

Besides the names I have enumerated, I am very much disposed to doubt if a score can be enumerated, or perhaps even half that number, of others in the same fields who during the last twenty years possessed conspicuous claims to admission to the Society. Nor can I believe that if men like the late Bishops of Oxford and London or Freeman had been willing to become candidates there would have been any likelihood of their being unsuccessful. Like Thorold Rogers, whom I often urged to allow himself to be proposed, they may not have desired admission. W. T. THISELTON-DYER.

Kew, May 6.

The Spectra of Carbon Monoxide and Silicon Compounds.

A PAPER published by Prof. Hartley (*Proc.* Roy. Soc. vol. lxviii. pp. 109-112, March, 1901) reminds me of some observations on the spectra of the compounds of silicon with fluorine and hydrogen ($SiFl_4$ and SiH_4), made by me several years ago and published in *Wiedemann's Annalen* (vol. xxi. pp. 427-437, 1884). As they seem to be not without some interest, and a definite explanation of them has, so far as I know, not been given till now, I may be permitted to give here a short account of the principal contents of my little paper.

A vacuum tube filled with $SiFl_4$ and procured from Geissler Nachfolger, in Bonn, showed a spectrum of which the greatest part consisted in the well-developed band spectrum due to carbonic oxide, besides which there appeared the eight beautiful blue lines, or rather stripes, that seemed (at least then) to be characteristic of $SiFl_4$. Now there is nothing wonderful about the presence of traces of the carbonic oxide spectrum in a vacuum tube, as is well known, but in our case it was so predominant, as if one had not simply to deal with impurities, but on the contrary, as if it was the principal part of the phenomenon. Intending to clear up the circumstances, I tried to prepare vacuum tubes from which the presence of carbonaceous matter, as well as of air and moisture, were as much as possible excluded, and finally the $SiFl_4$ gas was developed from a mixture of pure glass and flourspar powder and also purest sulphuric acid in an apparatus composed entirely of glass and sealed directly to a Toepler mercurial pump. All stop cocks and sliding pieces that want greasing were totally avoided. Nevertheless, the carbonic oxide spectrum remained in its very predominant position; at low pressures it was even present almost alone, as if one were working on a carbonic oxide tube containing some impurities due to silicon combinations. Sometimes, it is true, the carbonic oxide bands were less brilliant, and the blue stripes (belonging to $SiFl_4$?) more prevailing, from what cause I do not know, but still the carbonic oxide spectrum always remained well visible. Perhaps it is worth mentioning that sometimes there were seen four additional lines situated more towards the violet end of the spectrum, and occasionally, also, some green ones. Also the well-known swan spectrum could be obtained, especially when the discharges of a Leyden jar were sent through the vacuum tube. Even tubes illuminated in the well-known manner without the use of electrodes still showed the carbonic oxide spectrum in its predominant position. If some traces of oxygen had been developed from moisture, which, as is well known, it is almost impossible to totally remove from the glass apparatus used, and this had, by combining with some carbonaceous compound present in the tube given rise to some traces of carbonic oxide, then one could, so far as I know, only have expected a rather faint spectrum due to it. I do not know if the suggestion of carbon being contained in the element silicon is at all acceptable, according to present knowledge, but at all events the brilliant appearance of the CO bands awaits, as I believe, a sufficient explanation.

In a rather high vacuum this CO spectrum is not seen, but there are visible (except lines due to mercury, hydrogen, &c.) some lines also observable in highly exhausted tubes filled with carbonaceous compounds, but which, as I found in the latter case, only appear when luminous points are seen at the electrodes and the glass covers that partially surround them. As I found those lines to coincide with lines observed in the spark spectrum of $SiFl_4$ at high pressures, this so-called vacuum spectrum probably belongs to some silicious matter evolved out of the above-mentioned glass covers by the action of the said bright points.

Under suitable conditions SiH_4 also showed the carbonic oxide and swan spectrum, and as well the one ascribed to hydrogen, this latter especially being seen at lower pressures, whilst of a silicon spectrum nothing was observable. Only at higher pressures, by the aid of spark discharges, some of the lines were obtained that had been seen formerly in the spark spectrum of $SiFl_4$.

As my principal object in these researches had only been to get rid of the carbon spectrum (though in vain), I did not make any measurements of wave-length. Later on, as many laboratories were provided with powerful spectroscopic apparatus, I did not believe it to be any longer worth while to work on the subject with small instruments, hoping some other investigator would take care of it. I should be very glad if the present note would induce some spectroscopist to control and further pursue my observations. In addition, some researches with very strong sparks seem to me to be very desirable.

Berlin. KARL V. WESENDONK.

The Dust of "Blood-Rain."

I HAVE handed to Prof. Judd the specimens of "blood-rain" dust collected by me in Sicily, as mentioned in your issue of March 28. It may be remembered that the dust was collected from three tables on the terrace of the hotel, and that I brought home that from the most favourably situated table in the wet state in which it was obtained. This has since been dried and weighed, with the result that, as I expected, the density of the fall was greatest on this table, being equivalent to $9\frac{1}{4}$ tons per square mile. The average given by the other two tables was $5\frac{1}{2}$ tons per square mile.

The largest value is probably the best, but if we take the mean we shall be within the mark in saying that the density of the fall near the theatre at Taormina was about 7 tons to the square mile. ARTHUR W. RÜCKER.

A Convenient Primary Cell.

IN your "Notes" of April 18 (p. 594) you give an account of the new cell—the Cupron-element—brought out by the Accumulator Industries Company. Without intending any disparagement, will you allow me to point out that the cell, with the exception of the special form of copper oxide for which the company justly claim credit, was invented long ago by Lalande, but does not appear to be known so widely as its merits deserve. I have used the cell for a considerable time, the positive plate taking the form of a plate of copper faced on one side with granular copper oxide held in its place by a piece of copper gauze, and can corroborate the statements as to its very low resistance and great constancy. For elementary work, where resistances of a few hundredths of an ohm are to be compared and a galvanometer of negligible resistance used, I have found it most valuable. Another form of the cell, in which the copper plate is merely painted with a mixture of copper oxide powder and gum and then heated until the latter chars, is very readily set up, but has a rather greater internal resistance. Where this is desirable it may be regulated within considerable limits by making the cell a "sawdust Lalande," which has obvious advantages on other grounds. A. E. MUNBY.

Felsted.

THROUGH the kindness of the Editor I am able to reply to Mr. Munby's interesting letter. I did not intend by my note to imply that the "Cupron-element" was an entirely new combination, and indeed suggested that its chief claim to novelty lay in the construction of the copper oxide plate. The Accumulator Industries, Ltd., it is only fair to say, fully acknowledge in their circular that the cell is developed from the copper oxide element of Lalande and Chaperon. It is interesting to have Mr. Munby's testimony to the convenience of the cell, which is, I believe, used to a considerable extent on the Continent, but, as your correspondent says, is not very widely known in England.

THE WRITER OF THE NOTE.

AGRICULTURAL SEEDS.

UNDER the auspices of the Board of Agriculture a committee was appointed last summer to take into consideration the conditions under which agricultural seeds are at present sold, and to report whether any further measures can, with advantage, be taken to secure the maintenance of adequate standards of purity and germinating power.

The committee met on ten occasions and examined upwards of thirty witnesses, seed-merchants, farmers and scientific witnesses, including Mr Carruthers, Mr. Gilchrist, Mr. Hall, Profs. T. Johnson, McAlpine and Somerville. The evidence of these witnesses is now published as a Blue-book, whilst the report of the committee is issued separately.

Taking the report first, the committee find that there is [now] no wide-spread complaint of the quality of seeds sold throughout the country. The committee, further, think that every encouragement should be given to seed-merchants to give a guarantee with the seeds they sell, and that farmers should be advised to buy only subject to such guarantee and to test the seeds they have purchased. To facilitate this the committee recommend the establishment of one central seed-testing station under Government auspices, with the aid and counsel of a small committee of experts. The report is signed by all the members of the committee. Two of their number, Sir W. T. Thiselton-Dyer and Mr. Leonard G. Sutton, while agreeing generally with the findings of the committee, raise objections to the proposal to establish a Government seed-testing station.

It is satisfactory to hear that the general quality of the seeds sold has greatly improved of late years. This improvement is, no doubt, in great measure due to the passing of the Adulteration of Seeds Act, an Act, it may be pointed out, which was promoted by the seedsmen themselves, who desired to purify their business from seed-killing, seed-dyeing and other questionable practices which had been allowed to grow up to such an extent that it was difficult for a merchant to avoid conniving at, if not practising them.

At present, so far as the large firms are concerned, there is in general no question as to the excellence of the seeds they sell, and those who, like the writer of the present notice, have had the opportunity of witnessing the care taken in selecting the seed and in afterwards cleaning it and preparing it for market will corroborate this statement. With the smaller dealers, especially in some parts of Wales and Ireland, the case seems different. There the farmers often buy relatively small quantities of seeds of low quality and equally low price from local tradesmen, ironmongers, cornfactors and the like, who have no other knowledge of seeds than such as is necessary for securing the best means of disposing of them. It is especially for the protection of small, and often ignorant, farmers that the seed-testing station is intended.

All the large firms test their own seeds and the seeds they buy from the Continent or elsewhere. Moreover, they grow them in their own trial grounds. They do this on a very much larger scale than would be possible in a seed-testing station.

Some of the smaller firms, and perhaps some of the large houses also, occasionally make use of the seed-control stations at Zurich or Halle, and they find it a grievance that they have to send to Switzerland or Germany for information which obviously could as well be obtained here. Indeed, the botanists of the Royal Agricultural Society (Mr. Carruthers) and of the Highland and Agricultural Society of Scotland (Mr. McAlpine), and perhaps others, do undertake to test seeds for the members of their several societies, or, under certain conditions, for outsiders.

These tests, wherever they be made, have reference to the "purity" of the seed, its germinating power and its "genuineness." By purity is meant freedom from seeds of weeds or other admixtures. The germinating power is tested by the percentage of seeds in any given sample which, under favourable conditions, is found to produce healthy seedlings. Theoretically a hundred per cent. should grow. In practice the percentage may, without fault of the seedsman, be, in certain cases, much below this, but it is satisfactory indeed when one thinks of the many contingencies to which the clover plant is subjected to find it to be quite common for 98 per cent. of the seed to grow. When one thinks of the humble bees, and the mice and the cats and the vicissitudes of the climate, it seems remarkable that such a percentage of good seed should ever be obtained.

What seedsmen mean by the "genuineness" is another matter, but one of extreme importance. It would be quite impossible even for an expert to recognise seed of a particular stock or breed, say of broccoli or turnip. There are good stocks and bad "stocks" of these, but they cannot be distinguished by their seeds. A mere seed-testing station, private or official, could render no assistance in such cases. The only way to test the genuineness of a stock is to grow it and watch it throughout the season. Obviously the purchaser could not wait for that, he must trust to the good faith and reputation of the seedsman.

Considering, then, the vast scale on which seed-testing and seed-trials are now made by the leading firms and the limited scale on which seeds can be tested at a seed-testing station, and, further, bearing in mind that the ordinary seed-trials give no indication of "genuineness," we do not see that the farmer for his immediate practical purposes would be materially benefited by a seed-testing station. It would answer his purpose very much better to devote a little care to testing the seeds for himself from a sample procured some weeks before he required to sow for a crop. The seedsman, in his turn, should give a guarantee that the bulk should be equal, or closely approximate, to the sample. We say closely approximate because so numerous and so varied are the vicissitudes to which the seed is, or may be, exposed that some latitude, say to 5 or even 10 per cent., would only be reasonable.

Farmers in general sow much too thickly, so that a lower percentage than is theoretically desirable might well be condoned in practice if the seed were good of its kind.

While saying so much we are far from wishing to undervalue the importance of research-stations wherein the phenomena of germination as well as other physiological and pathological processes might be studied from the point of view of research. Associated with a small trial-ground, such stations would be very valuable for the investigation of the properties and mode of life, not only of old well-known crops, but also of new introductions. It is just here that the value of the "crank of a scientific man" would show itself. One of the witnesses objected to placing such a man at the head of a Government seed-testing station because "they get so infallible and then they take notions in their heads."

It is as well to see ourselves as others see us. We should have thought infallibility in this connection was a sign of nescience rather than of science.

MAXWELL T. MASTERS.

THE MARINE RESOURCES OF THE BRITISH WEST INDIES.

THE above is the title of a paper by Dr. J. E. Duerden, which, with a series of appendices, has lately been issued as an extra number of the *West Indian Bulletin*—the official journal of the Imperial Agricultural Department of the West Indies. As read, it formed the leading feature of a recent Congress at Barbados, held under the auspices of the aforenamed Department, at which representatives of all the West Indian Islands were present, and it sets forth in a concise and connected form the essence of all that has transpired in the utilisation for economic purposes of the rich resources of the West Indian seas. In the first part of the paper the fisheries of Jamaica, the Barbados, Bahamas, Leeward Islands, Trinidad, St. Vincent, British Guiana and Honduras are each dealt with in turn, mainly from the statistical standpoint; and then, in descending zoological order, there are treated the principal marine resources from the Mammals to the Sponges. The history of a movement of recent years to establish in the West Indies a marine biological station is next fully sketched, and its defence strengthened by a plea based on a comparison of the work achieved by institutions of the desired order existing elsewhere.

The paper shows that, in their utilisation, the marine resources of the West Indian Islands have long played a too limited part in the maintenance of the Colony itself, and that they fall short through being nowhere under the control of an organised plan. The yearly value of the fish caught is estimated at 30,000*l*., against that of fish imported at 147,000*l*., which is thus nearly five times the greater, while attention is directed to a diminution in the supply of the West Indian turtle and a decadence in more especially the "sea egg" industry, due to the effects of over-fishing and lack of scientific treatment, and, in the case of the turtle, due also to the "ceaseless capture of adults." Dr. Duerden, in discussing the remedies for these shortcomings, shows conclusively that they lie in a restocking process to be based on a practical knowledge of the life-history of the species rather than the establishment of closed seasons. Perusal of his paper shows that the importance of these two industries to the traders and inhabitants of the islands is so great that, under the present circumstances, immediate action should be instituted on their behalf.

Concerning the question of fish-capture, Dr. Duerden refers at some length to an unsuccessful attempt made in 1898 to gauge the trawling capacity of certain of the West Indian seas. He gives in full a copy of the log of the vessel employed, and in discussing the alleged failure he expresses the conviction that the venture (which was a private one) was too early suspended, and shows reason to conclude that the further introduction of northern methods without reference to tropical conditions is not likely to be successful. Claiming satisfaction for line-fishing at 200 fathoms, he is led to advocate the stake-net method lately introduced from America as specially fitted for use in bays and lagoons, if not among the coral reefs themselves. His paper shows that he has thoroughly mastered all branches of his subject, and proves beyond previous experience that the West Indian seas contain a rich fauna, which, systematically handled on scientific lines, ought materially to increase the resources of the islands, and thereby to aid in raising them from their present unsatisfactory condition.

Dr. Duerden institutes comparisons between the results obtained at the West Indies and those begotten of trained supervision and the establishment of a fisheries bureau, with its necessary plant and equipment, at the Cape and elsewhere, and he with much naïvety dwells upon the facts as calculated to affect, by competition, the Sponge industry of the Bahamas, financially the most important industry the Colony can boast. He points with justifiable emphasis to the need in the West Indies of a fisheries establishment, regarding it as a pressing necessity to enable the colonists to keep pace with the times and fully to maintain their position in competition and advancement beside the rest of the world.

Conspicuous among the marine biological establishments to which he points as exemplary, are those which have arisen in relation to the agricultural departments of localities at which they are placed; and the suggestion arises that a similar extension should be granted the Agricultural Department of the West Indies, now wholly botanical. Of the success which has attended the work in economic botany which Dr. D. Morris, the indefatigable director of this Department, has achieved in the short period which has elapsed since its foundation, our readers are aware; and we are informed by a local authority that he is eminently desirous of the extension of his sphere of influence in the direction of economic zoology. In Dr. Duerden he has at hand the one man who, by training and experience, is most familiar with the neighbouring West Indian seas and all that pertains to fisheries work upon them. Perusal of Dr. Duerden's paper is convincing as to the urgency of this matter, and we consider that the Government and those in charge of the Agricultural Department of the West Indies would be well advised did they provide, properly equipped, a laboratory of which he should be put in charge. To do so would be but to give the Department equal chances with others under Imperial control, to which it is closely akin.

Concerning the economic zoology of the West Indian seas then, everything tends to show that at the present time circumstances so combine that it may be said all is ripe for the initiation of a new departure, under which systematic work and organisation, guided by the light of science, may be profitably brought to bear. The local Press are advocating this course, and the special publication of Dr. Duerden's paper is the expression on the part of those best competent to judge of its desirability. Given this, and the scientific knowledge of the movements and life-histories of the denizens of the seas which would thus be obtainable, the hatcheries, curing-houses, wharves and trading-fleet would follow in due course; and it is certain that a moderate amount of assistance bestowed in the direction we have indicated might be the means of placing the depressed colonies in an improved position, and of thereby lessening their constantly-recurring charge upon the mother country.

THE LATE MR. SEEBOHM'S TRAVELS IN ARCTIC EUROPE AND ASIA.[1]

THE two well-known volumes, respectively entitled "Siberia in Europe" and "Siberia in Asia," in which Mr. Seebohm described his bird-nesting expeditions to the Petchora (1875) and Yenesei (1877) valleys, having long been out of print, the author determined to combine (and to some extent condense) the two narratives, and to issue them in single volume form. The greater portion of this task had been accomplished when it was unhappily brought to an abrupt close by the untimely death of the talented author. Its completion was thus of necessity left to another hand. Although the editor has not thought fit to make his identity known to the public, he may be congratulated on the tact and skill with which he has carried out his share of the work.

In one respect, and one respect only, are we disposed to find fault with the editor; and this in regard to the title chosen for the volume. In this respect, indeed, both author and editor are singularly unfortunate. "Siberia in Europe," the title of the first volume of the original work, is a geographical absurdity, and "Birds of Siberia" is but little, if at all, better. For, in the first place, at least half of the tract of country through which the author travelled has not the faintest shadow of a claim to be termed "Siberia," and, secondly, birds form by no means the sole topic on which the author discourses. "Egg-hunting in high latitudes," or some such title, would, we think, have been a far preferable designation.

Since Mr. Seebohm's account of his journey along the Yenesei was reviewed at considerable length in these columns when the original work was published, a very brief notice will suffice on the present occasion. The author's main object was to obtain nests, eggs and young of birds whose breeding habits were previously almost or entirely unknown; and his success in discovering the breeding places of the grey plover, little stint and other kinds of his favourite "Charadriidæ" are now matters of history. Migration was also a favourite subject of study and speculation on the part of Mr. Seebohm; and although we may be unable to assent to all his views and opinions with regard to this phenomenon, his account (p. 203) of the rush of migrating birds on Heligoland must remain fresh and interesting for all time.

"From the darkness in the east," he writes, "clouds of birds were continually emerging in an uninterrupted stream; a few swerved from their course, fluttered for a moment as if dazzled by the light, and then gradually vanished with the rest in the western gloom. . . I should be afraid to hazard a guess as to the hundreds of thousands that must have passed in a couple of hours . . . . The scene from the balcony of the lighthouse was equally interesting; in every direction birds were flying like a swarm of bees, and every few seconds one flew against the glass."

And Mr. Seebohm is equally happy when describing the habits of the birds and their young on the tundra, which formed the main object of his expeditions. The most striking illustrations in the book are undoubtedly those of the nest and young of the grey plover and little stint, but as these appeared in NATURE on a former occasion they are not repeated here, and we prefer to

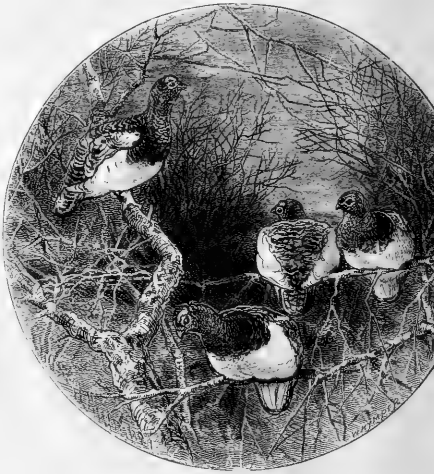


FIG. 1.—A group of willow-grouse. (From "The Birds of Siberia.")

give, as an example of Mr. Whymper's illustrations, the exquisite cut of willow-grouse which stands at the head of chapter xii.

But, as we have already indicated, Mr. Seebohm by no means confined his attention to birds, and his notes on the Samoyedes of the Petchora should form interesting reading to all students of anthropology, while his observations on reindeer can scarcely fail to attract all those who make a special study of the deer tribe. The sportsman, too, will find much interesting matter in many of Mr. Seebohm's pages.

Our opinion of the manner in which the editor has carried out his task has been already expressed; but we think he would have been wiser had he cut out the penultimate paragraph of the last chapter, which contains certain very unnecessary reflections on the mode of zoological work in vogue in this country.

As an interesting and well-written account of two adventurous journeys through little-known mosquito-haunted regions, the work should attract a large circle of readers.

R. L.

[1] "The Birds of Siberia; a Record of a Naturalist's Visit to the Valleys of the Petchora and Yenesei." By Henry Seebohm. Pp. xix + 512. Illustrated. (London: Murray, 1901). Price 12s. net.

SCOTCH SCENERY AND GEOLOGY.[1]

THE five-and-thirty years which have elapsed since the first edition of this work appeared have witnessed great advances in certain departments of geology, especially those which are all-important in that of Scotland. In 1865 the northern and central Highlands were confidently asserted to be metamorphosed Silurian sediments, and the complexities of the southern uplands were unsuspected. Now the secret of the Highlands and the mystery of the Lowlands have been discovered, thanks mainly to Prof. Lapworth, and although riddles yet remain unsolved in the former, particularly near the southern border, the members of the Survey can work with confidence on their leading principles of interpretation. Even since 1887, the date of the second edition, no small advances have been made, so that we are not surprised to read that the present edition has been thoroughly revised and considerably enlarged. Since the first one, in fact, the greater part of the book has been rewritten, and so much new matter incorporated that we soon lose our way in trying to compare the two volumes page by page. In some respects there are omissions, for several points, open to debate in 1865, may now be taken for granted; while on others, opinions then commonly entertained are now repudiated. For instance, we are no longer told that the greywacke and shale of the southern uplands have been in some places changed into serpentine, felstone or granite.

FIG. 1.—Brig o' Trams Wick. (Cliffs of Old Red Flagstone, illustrating bedding, joints and weathering.)

But, though many disputed points are now settled, others still remain. Personally, we should not assume that an ice-sheet had crossed from Scandinavia to the eastern coast of England, or had deposited the boulder clay on the northern heights of London; we should not have left, without fuller discussion, the possibility of the larger lake basins being mainly formed by earth flexures after the valleys had been excavated; nor should we have so readily accepted the parallel roads of Lochaber as produced on the shores of lakes the waters of which were retained by dams of ice. But time will settle these disputes, as it has settled, during the last quarter of a century, differences yet more fundamental. Enough to say that the new edition of "The Scenery of Scotland" ought to be the companion of every one who does not visit the country merely to kill animals or to say he has been there. The itineraries at the end, with their references to the volume, and the four maps, bringing out so clearly the geology and physical features, will teach the traveller, pleasantly and as easily as may be, to interpret the works of nature in that wonderful land.

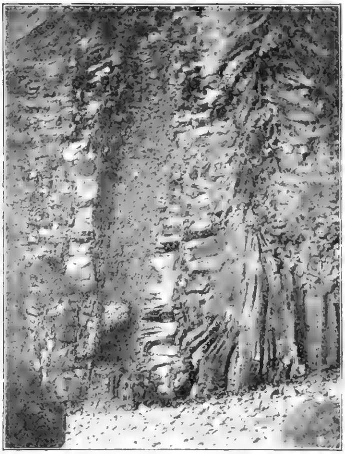


FIG. 2.—Erect Coniferous tree in basalt, Gribun, Isle of Mull.

The excellent illustrations—much more numerous and far better executed than those in the first edition—of which we give specimens, will greatly help the learner. Besides this, the book, though so much enlarged, has not lost its original literary charm. We have always considered the first edition to rise even beyond the high level which the author is wont to maintain, and so took up this with some apprehension that, as often happens in real life, the child had lost its beauty in growing up. A change there has been; the book has reached its full stature but retains its attractiveness, while it has increased in power. Hence, in congratulating Sir Archibald Geikie

[1] "The Scenery of Scotland viewed in Connection with its Physical Geology." By Sir Archibald Geikie. Third edition. With four maps and numerous illustrations. Pp. xxii + 540. (London: Macmillan and Co. Ltd., 1901.) Price 10s. net.

on this appropriate close to his more professional work, we express an earnest hope that it will be not a few years before the inevitable *finis* is written on his scientific and literary career. T. G. B.

DINNER TO SIR ARCHIBALD GEIKIE.

THE complimentary dinner to Sir Archibald Geikie on May 1, provided a means of giving public expression to the regard in which he is held, not only in the scientific world, but also by leaders in other branches of intellectual activity. The representative character of the dinner was very noteworthy, as will be seen from the following list of those present :—

Rt. Hon. Lord Avebury, Sir Archibald Geikie, Sir G. G. Stokes, Bart., Sir F. Abel, Bart, Major-General Sir J. Donnelly, Admiral Sir. W. Wharton, Sir John Evans, Sir Norman Lockyer, Sir Henry Craik, Sir John Murray, Sir Michael Foster, Sir William Turner, Sir Henry Howorth, Sir Henry Roscoe, Sir Lauder Brunton, Major-General Festing, C.B., S. Spring-Rice, C.B., Digby Pigott, C.B., Major-General McMahon, Colonel Johnston, Colonel Bushe, Major Craigie, Rev. Prof. Bonney, Rev. Prof. Wiltshire, Prof. T. McK. Hughes, Prof. Sollas, Prof. Ray Lankester, Prof. C. le Neve Foster, Prof. J. Geikie, Prof. E. Hull, Prof. Joly, Prof. Jack, Prof. Corfield, Prof. Lapworth, Prof. Watts, Prof. Seeley, Prof. Garwood, Prof. T. Groom, Prof. G. A. J. Cole, Prof. W. Galloway, Prof. H. Bauerman, Prof. R. A. Gregory, Prof. Evan Small, Dr. F. Moreno, Dr. W. Blanford, Dr. P. L. Sclater, Dr. Scharff, Dr. F. Parsons, Dr. George Ogilvie, Dr. Tempest Anderson, Dr. Horace Brown, Dr. Scott Keltie, Dr. Hugh R. Mill, Dr. J. W. Evans, Phipson Beale, K.C., H. Arnold Bemrose, J. E. Bartholomew, E. Best, F. Best, C. Borchgrevink, B. H. Brough, G. L. Craik, C. Fox-Strangways, Roderick Geikie, E. Greenly, George Griffith, A. Harker, R. S. Herries, T. V. Holmes, W. H. Hudleston, R. L. Jack, D. A. Louis, J. E. Marr, F. Macmillan, G. A. Macmillan, H. W. Monckton, George Murray, E. T. Newton, Grant Ogilvie, J. Parkinson, F. W. Rudler, A. Strahan, H. J. Seymour, J. J. H. Teall, C. Tookey, W. Whitaker, H. B. Woodward, Martin Woodward.

FIG. 3.—Rock terraces of old sea margins, Isle of Jura.

The list shows that the different public departments with which the Geological Survey is most closely connected were well represented, including the Treasury, Admiralty, Board of Education, Local Government Board, Board of Agriculture, Ordnance Survey, Scottish Education Office, Stationery Office and British Museum. There were likewise present the professors of geology in London, Oxford, Cambridge, Edinburgh, Dublin and Birmingham, together with numerous other Fellows of the various learned societies. Letters, telegrams and addresses of felicitation were received from all parts of Europe and America. The following telegram from Christiania was read by the chairman: "Also from Norway's mountains an echo of the cheers for the master of English geology—Brögger, Helland, Nansen, Reusch, Vogt."

Lord Avebury, in proposing the health of the guest of the evening, said :—

Sir Archibald was educated at the Royal High School and University of Edinburgh, which must indeed be very proud of him. He commenced his official career in 1855, when, at the early age of nineteen, he was appointed to a post on the Geological Survey, and in 1867 was made director for Scotland. In 1871 he became professor of geology at Edinburgh, and held the post till 1881, when he resigned it on his appointment as director-general of the Geological Survey and director of the Museum of Practical Geology in Jermyn Street, which he has since held with credit to himself and great advantage to geological science. Every one would admit (1) that the Geological Museum was a model museum, (2) that the Geological Survey has been admirably managed and that Sir Archibald has organised a splendid staff, (3) that the maps and memoirs of the Geological Survey are admirable contributions to science and an honour to all concerned.

Sir Archibald was one of the first field geologists to realise the value of microscopic sections of rocks, and under his superintendance some thousands of slides were made and added to the Jermyn Street Museum. Under his able successor, whom we all congratulate on his appointment, we may be sure that this branch of the science will not be negelcted.

Besides his official duties Sir Archibald has contributed to the progress of science by much original work, comprising nearly 100 separate memoirs; to scientific education by his primers and text-books, which are models of clearness; to scientific literature by his admirable "Text-book of Geology," his "Geological Sketches at Home and Abroad," "Founders of Geology," "Memoir of Ramsay," "Life of E. Forbes," "Life of Murchison," &c.

Others also of his books are important as contributions to science, and also in rendering it more accessible and more interesting to the general reader, such as his charming "Scenery of Scotland" and "The Ancient Volcanoes of Britain." These seem to me models of what such books should be, combining, as they do, scientific accuracy with a love of scenery, and the power of description in happy and expressive words, for Sir Archibald combines with the striking qualities of a geologist those of an enthusiastic lover of nature. He is an artist in two senses, both with pen and pencil, for his sketches add much to the vividness and clearness of his writings.

Our countrymen have not always received fair play from foreigners, but I am happy to say that, among men of science at any rate, the most friendly and harmonious relations exist; we cordially acknowledge the splendid services they have rendered to science, and recognise that, in this respect at any rate, our international relations are pleasant and harmonious. For this also we are greatly indebted to Sir Archibald Geikie.

Sir Archibald is now retiring from his official duties, and the additional leisure which he will enjoy will in great measure, we may be sure, be devoted to the prosecution of geological research.

He has received many well-deserved honours. He was made F.R.S. before thirty; has been vice-president and foreign secretary of the Royal Society and received a Royal Medal; also the Macdougal-Brisbane Medal of the Royal Society of Edinburgh, and the Wollaston and Murchison Medals of the Geological Society. He is an associate of most of the chief academies of Europe and America, D.C.L. of Oxford, D.Sc. of Cambridge and Dublin, and LL.D. of Edinburgh and St. Andrews. He received the honour of knighthood in 1891.

But it is not merely to do honour to a great geologist that we are here to-night, but to express our warm feelings towards an old and valued friend and to congratulate him on his well-earned honours. Sir Archibald, we drink your health, and for our own sakes, as well as for yours, we hope that you have before you many years of health and happiness.

The chairman then presented Sir Archibald with an illuminated address from his colleagues of the Geological Survey and Museum in the following terms:—"We desire, upon the close of your tenure of office, to express our sense of the high value of the services which you have rendered to these Institutions; we proudly recognise the high position attained by you in the scientific world and gratefully acknowledge the beneficial influence of your example. That you may long live, after more than forty-five years in the public service, to enjoy your freedom from official cares and to enrich geological literature with your luminous writings is our earnest desire."

Sir Archibald Geikie replied as follows:—

You may well believe that on such an occasion as this it is hardly possible for a man adequately to express the feelings that overpower him. If "silence is the perfectest herald of joy," this is no less true of gratitude. Hence, were that permissible, I would fain simply thank you in the fewest words for this manifestation of your friendly regard. To you, my lord, I am deeply indebted for all the kind words you have been pleased to say of me and my work, and to you, my friends, my debt is not less for the way in which these kind words have been received and re-echoed by you. The feeling, next to overpowering gratitude, which rises uppermost in my mind is a bewildering wonder why so much kindly appreciation and good-will should have been in this way showered upon me. And yet on reflection I recognise that it is only the culmination of what has been so liberally extended to me all my life. When I look back into the past, the vista of fifty years seems to me crowded with friendly faces and helpful hands, ready at every turn with wise counsel or stimulating sympathy and encouragement. Most of these voices have long been silent for ever, but their sound still lingers in my ears. It is to their aid and guidance that I stand mainly indebted for anything that I have been able to do in the cause of science, and I should be ungrateful and unworthy if on this memorable occasion I failed to acknowledge my indebtedness.

At the outset of my career there were four men who specially befriended me and set me in the path which I have followed ever since. The first of these was James Pillans, professor of Latin (or Humanity as it is called in the north) in the University of Edinburgh. As he was teaching for more than half a century, a large part of the population had passed through his hands. Robert Chambers used humorously to divide mankind into two sections—those who had been under Pillans and those who had not. I am glad to have belonged to the former section. Pillans's name is perhaps most widely known from the savage and wholly undeserved slander of him inserted by Byron in his "English Bards and Scotch Reviewers." As I knew him he was a genial old man, with much of the gravity and stiffness of an eighteenth century pedagogue, but with a kindly nature, a vein of chivalrous sentiment and an enthusiasm for classical literature to which his best students owed much. He was an educational reformer well in advance of his time. In particular, he used to insist on the study of physical geography as a necessary accessory in all historical inquiry. When the story of the progress of education in this country is fully written, an honoured place will be given to Pillans. Horace was his favourite author, and as I was fond of turning the odes into English verse and illustrating them with parallel passages from other authors, my exercises procured me first his notice and then his friendship, which he continued to the end of his life. Knowing my taste for geology, he asked me to meet Leonard Horner at breakfast, and in this way indirectly led to my introduction to Lyell and to the Geological Society of London.

Another teacher whose influence and help were great was George Wilson, well known to chemists for his able researches on fluorine, and to a much wider public for his delightful literary essays. In his laboratory I studied chemistry. It was he who first opened out to me the prospect of employment in the Geological Survey and eventually introduced me to Andrew Crombie Ramsay.

Hugh Miller, by his writings, and still more by the personal charm of his conversation, as he discoursed over the fossil treasures in his museum, finally confirmed my determination to give my life up to geology, if that were found to be practicable. It was he who first brought my name before Murchison, then newly appointed Director-General of the Geological Survey.

To William Edmond Logan, Director of the Geological Survey of Canada, it is a pleasure to acknowledge my deep indebtedness. From time to time he used to return to this country, and on each of his visits to his brother, who was a lawyer in Edinburgh, I was privileged to spend long hours with him, while he spread his Canadian maps on the floor and gave me graphic pictures of his life and work, with the help of his well-filled sketch-books and note-books. After such interviews, as you may well believe, the determination to become a geologist took deep root.

At that time, however, now half a century ago, the outlook for employment in a geological capacity was neither very wide nor very clear. Robert Chambers, probably most widely known now as the author of the once famous "Vestiges of Creation," but, I venture to think, best deserving to be remembered for his pioneer work in glacial geology, rather sought to dissuade me from the Survey. I remember that one of the reasons he gave was that he hardly thought I possessed strength and appetite enough for the life of a professional geologist. He had lately been in Wales with a Survey party, consisting, if I remember, of Ramsay, Selwyn and Jukes, and being the oldest member of the company was unanimously voted into the chair, where he had the duty assigned to him of carving a leg of Welsh mutton. He described the prodigious capacity of the geologists for food, and the incredibly short time that passed before he had nothing but a bare bone in front of him.

In the early autumn of 1855 I had an interview with Murchison at his hotel in Edinburgh. He looked a little doubtfully at my youthful and slight figure, but was reassured by Ramsay, whom I had shortly before taken on a geological excursion in the neighbourhood. The chief remarked to me that a pair of good legs were of about as much use as a head to a geologist. I joined the staff in the following October. Six years later I accompanied Murchison in a long geological tour through the Highlands, and as the climbing all fell to me, he was quite satisfied as to the capacity of my legs. That expedition secured for me his lasting friendship. He never lost an opportunity of aiding me. Underneath a somewhat stiff military manner he carried a warm heart. Among all my benefactors there is none to whom I owe so much and for whose memory I cherish a warmer regard.

The Geological Survey was then a much smaller establishment than it has since become. Originally placed under the Board of Ordnance, its members wore a military uniform; but on the transference of the organisation to the Civil Service this uniform was discarded, though, as in the case of the "poor workhouse boy," the gilt buttons survived, and with their crossed hammers and crown continued for many years afterwards to be sported on the vests of the Survey men at their annual festivities. Who shall describe the delights of the Survey life in the field, when what had been the employment only of an occasional precious holiday, became the absorbing occupation of one's life? We had pessimists on the staff then as now. One of these continually reminded us that as ours was a service depending for its maintenance upon an annual vote of Parliament, which might some fine day be refused, we should all hold ourselves prepared to find something else to do.

When I joined the staff the system of Civil Service examinations had lately been authorised by Act of Parliament, but had not yet been brought into working order. I used to be warned from time to time by one lugubrious member of the Department that I had better get myself examined in time, otherwise I would probably endanger my pension, if I lived long enough to claim it. But I knew that, as the examinations were then framed, I should infallibly be plucked. I could not, for example, have given the precise ages of each of Henry the Eighth's wives, nor could I have done a sum in compound addition three feet long in ninety seconds. So I thought it best to let a sleeping dog lie. I never passed any examination, and I am happy to assure you that the Treasury has not refused me my pension.

No member of the Survey who served under Ramsay will ever forget the charm of his presence, his radiant good humour, his unvarying helpfulness, his acuteness in criticism, his sagacity in geological discussion and the little petulances and whims that made his society so irresistibly amusing. His beneficent influence was long one of the great features of the service, and we owe to him, not only the recollection of his delightful personality, but the guidance and encouragement which have carried us through our work.

To my colleagues in the Survey who have prepared and signed this beautiful address my heartiest acknowledgments are due. It will remain with me as a precious memorial of many close and enduring friendships. Each signature will remind me, now of some delightful ramble in the country when geological problems were eagerly discussed on the ground, now of some momentous conference in the office when the plan of campaign or the details of maps and memoirs were fully considered and settled.

During my tenure of office as Director-General I have been ever supported by the loyal and unstinted devotion of the staff. It has been an honour and a pleasure to be placed at the head of such a body of men—so enthusiastic in their whole-hearted consecration to science and so unwearied and loyal in their efforts for the interests of the service. I feel sure that in no branch of the public service could the *esprit de corps* be higher than it has been among us. You can well understand that it is impossible without regret to sever one's connection with comrades such as these. At the end of my official career, however, I can truthfully claim to have striven to the utmost of my power for the welfare of the staff and for the scientific renown of the service. I have sought to secure the very best men whom it was possible to obtain, and I feel very confident that the Geological Survey, as regards the zeal, capacity and attainments of its members, may challenge comparison with any scientific institution in any country of the world. I rejoice to think that the service is being now put on a firmer footing than it has ever held before, that the prospects of pay and promotion have been lately broadened and brightened, and that, under the guidance of my distinguished friend and successor, the Survey may look forward to a future even more illustrious and more useful than its past. Gentlemen, I thank you all once more from the very bottom of my heart.

THE ROYAL SOCIETY SELECTED CANDIDATES.

FOLLOWING our usual course, we print the qualifications of the fifteen candidates selected by the Council of the Royal Society on Thursday last, for election into the Society:—

ALFRED WILLIAM ALCOCK,

Major, I.M.S., M.B., C.M.Z.S. Superintendent of the Indian Museum; Professor of Zoology in the Medical College, Calcutta. Distinguished as a zoological investigator and teacher, and as a museum curator. Was Surgeon Naturalist to the Marine Survey of India, from 1888 to 1892, on board the Royal Indian Marine Ship *Investigator*, also to the Pamir Boundary Commission in 1895. Has devoted himself chiefly to the study of marine zoölogy with especial reference to fishes, crustacea, echinoderms and madreporaria, and to problems connected with the geographical distribution of the Indian representatives of these groups, and the phenomena of viviparity in fishes. Author of an extensive series of memoirs, papers and reports dealing with the aforementioned subjects, published during the past ten years in the *Proceedings* of the Royal Society, the *Journal* of the Asiatic Society of Bengal, the *Annals and Magazine of Natural History*, and in the series of publications of the Indian Museum, and "Scientific Memoirs" by the Medical Officers of the Indian Army, and elsewhere. Some of these (*e.g.* the series entitled "Materials for the Carinological Fauna of India") are revisionary monographs of the groups with which they deal, and in others (*e.g.* the Survey of the Deep Sea Zoological work of H.I.M.S. *Investigator* for 1884–1897, and the "Deep Sea Madreporaria") the general bearing of the zoogeographical problems arising out of the work are fully discussed in their association with the facts and theories of oceanographical research. In connection with the work of the *Investigator* he originated, in 1892, the serial publication, "Illustrations of the Zoology of the *Investigator*," now progressing.

FRANK WATSON DYSON,

M.A. (Cantab.), Chief Assistant (since 1894) Royal Observatory, Greenwich. Late Fellow of Trinity College, Cambridge. Secretary of Royal Astronomical Society. Author of various papers on mathematics and astronomy, among which may be mentioned:—"The Potential of Ellipsoids of Variable Densities" (*Quart. Journ.*, Pure and Applied Mathematics, No. 99, 1891); "The Potential of an Anchor Ring" (two papers—*Phil. Trans.*, 1893, pp. 43–95 and 1041–1106); "The Motion of a Satellite about a Spheroidal Planet" (*Quart. Journ.*, Pure and Applied Mathematics, No. 105, 1894); "The Effect of Personality in Observations of the Sun's Right Ascension on the Determination of the Position of the Ecliptic" (with W. G. Thackeray, *Monthly Notices, Roy. Astron. Soc.*, vol. liv., 1894); "Account of the Measurement and Comparison of a set of four Astrographic Plates" (with W. H. M. Christie, *ibid.*, vol. lv., 1894); "On the Determination of the Positions of Stars for the Astrographic Catalogue at the Royal Observatory, Greenwich" (with W. H. M. Christie, *ibid.*, vol. lvi., 1896); "New Division Errors of the Greenwich Transit Circle and their Effect upon the observed N. P. D.'s (with W. G. Thackeray, *Mem. Roy. Astron. Soc.*, vol. liii., 1899); "Comparison of the Diameters of the Images of Stars on the Greenwich Astrographic Plates, with the Magnitudes given in the 'Bonn Durchmusterung'" (with H. P. Hollis, *Monthly Notices, Roy. Astron. Soc.*, vol. lx., 1899). Distinguished as an astronomer.

ARTHUR JOHN EVANS,

M.A. Hon. Fellow of Brasenose College, Vice-President of the Society of Antiquaries, Keeper of the Ashmolean Museum, Oxford. Distinguished as an archæologist and anthropologist. Mr. Evans's recent discoveries in Crete have been of the highest importance as throwing an entirely new light on the early civilisation of the Ægean and Mediterranean areas, and proving the hitherto unknown fact that a Præ-Phœnician form of writing was in use within those areas during the Mycenæan period. Starting from certain engraved gems, some of them found in Crete, the figures on which he suspected to be alphabetic or syllabic signs, he was led by inductive reasoning to infer that in that island there must exist monuments of a præ-historic system of writing. For some years he has carried on investigations in Crete, with the final result of bringing to light, in what seems to be the Palace of King Minos, or the famous Labyrinth, upwards of a thousand clay tablets, inscribed with documents in both a pictographic and a linear system of writing, as well as remains of artistic work of remarkable interest. The existence of a high stage of Mediterranean culture, about 2000 B.C., has thus been established, and the use of writing among Hellenic peoples has itself been carried back to a date at least 500 years earlier than has hitherto been regarded as possible. Of Mr. Evans's other published works may be cited his researches in the anthropology and antiquities of Illyricum and Dalmatia, and his numerous memoirs relating to the Iron Age, the Mycenæan Period, the late Celtic or Early Iron Period, and generally the connection of Egypt and the East with the dawn of European civilisation. His works on the coinages of Tarentum and Sicily are standard authorities, and after the death of Prof. Freeman he completed that eminent writer's "History of Sicily."

JOHN WALTER GREGORY,

D.Sc., F.G.S. Professor of Geology in the University o. Melbourne. Explorer of Mount Kenya, and author of "The Great Rift Valley." Has contributed a large number of papers to] scientific publications on Palæontological, Petrological and Physiographical questions; for example, on the Maltese fossil Echinoidea (*Trans. Roy. Soc.*, Edin.); on British Palæogene Bryozoa (*Trans. Zool. Soc.*); on the Echinoidea of Cutch and on the Corals of Cutch (Palæont. Indica); on Pseudodiadema Jessoni; on Archæodiadema; on Echinocystis, &c., besides the volumes in the British Museum Catalogue on the Jurassic and the Cretaceous Bryozoa. In Petrology he has written in the *Quarterly Journ. Geol. Soc.* on the Tudor specimen of Eozoon, the Variolites of the Fichtelgebirge, the Waldensian Gneisses, the Schistes Lustrées of Mont Jovet, the Geology of British East Africa (three parts), and (in collaboration) the Variolites of the Mont Genevre, the Geology of Monte Chaberton, the Eozoonal structure of ejected blocks, Monte Somma, &c., and among several papers in Physical Geology, the Glacial Geology of Mount Kenya, and (in collaboration) Contributions to the Glacial Geology of Spitzbergen.

HENRY BRADWARDINE JACKSON,

Captain, R.N., Naval Attaché to the British Embassy, Paris. Invented (1886) a practical system of electrically illuminating gun sights for firing at night, which was adopted and used for some years in H.M. Navy, but has since been replaced by later methods. Proved (1888) that considerable stability is necessary in order that a totally submerged automobile torpedo may maintain a straight course. Has given much attention to the theory and practice of aërial telegraphy. Invented a serviceable apparatus for signalling between ships at sea without wires. Proved that if the Hertzian oscillations are transmitted and received by vertical wires, the distance to which effective signals can be sent tends to vary within limits as the product of the lengths of the wires.

HECTOR MUNRO MACDONALD,

M.A., Fellow of Clare College, Cambridge. University Lecturer in Mathematics. Distinguished for original work in Mathematics and Mathematical Physics. Author of the following papers:—"Torsional Strength of a Hollow Shaft" (*Proc. Camb. Phil. Soc.*, viii.); "Self-induction of two Parallel Conductors" (*Trans. Camb. Phil. Soc.*, xv.); "Waves in Canals" (*Proc. Lond. Math. Soc.*, xxv.); "Waves in Canals and on a Sloping Bank" (*ibid.*, xxvii.); "Electrical Distribution on a Conductor bounded by two Spherical Surfaces cutting at any Angle" (*ibid.*, xxvi.), and a Note on the same (*ibid.*, xxviii.); "Electrical Distribution induced on a Circular Disc placed in any Field of Force" (*ibid.*, xxvi.); "Electrical Distribution induced on an Infinite Plane Disc with a Circular Hole in it" (*ibid.*, xxvii.); "Electrical Distributions on Cones" (*Camb. Phil. Soc. Trans.*, "Stokes memorial" volume); "Note on Bessel Functions" (*Proc. Lond. Math. Soc.*, xxix.); two papers on the Zeroes of the Bessel Functions (*ibid.*, xxix. and xxx.); "Zeroes of the Harmonic $P_n^m(\mu)$ considered as a Function of μ" (*ibid.*, xxxi.).

JAMES MANSERGH,

M.Inst.C.E., Civil Engineer. President of the Institution of Civil Engineers. Author of "Lectures on Water Supply, Prospecting for Water, Prospecting and Boring," delivered at the School of Military Engineering, Chatham, also of "The Supply of Water to Towns," and other works. The designer of the waterworks and sewerage of Lancaster, Lincoln, Stockton, Middlesbrough, Rotherham, Southport, Burton-on-Trent, Melbourne (Australia), Birmingham and many other towns. These designs include some of the largest schemes of water supply and drainage ever carried out. Author of about 140 reports upon schemes of water supply, sewerage or sewage disposal for Halifax, Hereford, St. Helens, Darlington, Whitby, the Potteries, Derby, Southampton, Durham, Shrewsbury, Malvern, Cambridge, Edinburgh, Plymouth, York, Antigua, Philadelphia (U.S.), and other places. Was a member of the Royal Commission on Metropolitan Water Supply. Eminent as a hydraulic engineer.

CHARLES JAMES MARTIN,

M.B., D.Sc. (Lond.). Professor of Physiology in the University of Melbourne. Is eminently distinguished as an original investigator in Physiology. His chief original papers deal with the Chemistry and Physiological Action of Snake Venom, and with the action and reaction of Toxins and Antitoxins. Author of:—"The Chemistry of the Venom of the Australian Black Snake" (*Proc. Roy. Soc.*, N.S.W., 1892); "The Physiological Action of the Venom of the Australian Black Snake" (*ibid.*, 1895); "Curative Action of Calmette's Serum against Australian Snakes" (*Internat. Med. Journ.*, 1897–98, and *Proc. Roy. Soc.*, 1898); "Nature of the Antagonism between Toxins and Antitoxins" (*ibid.*, 1898, joint Author); "Separation of Colloids and Crystalloids by Filtration" (*Journ. of Physiology*, 1896); "Observations on the Anatomy of the Muzzle of *Ornithorhynchus*," with Dr. Wilson (Linn. Soc., N.S.W., 1892); "Observations on the Femoral Gland of *Ornithorhynchus*," with Dr. Tidswell (Linn. Soc., N.S.W., 1894); "An Investigation into the Effects of the Darling Pea, *Swainsonia galegifolia*" (Agricultural Department of N.S.W.); "Cerebral Localisation in Platypus" (*Journ. Physiol.*, 1899).

RONALD ROSS

Major (I.M.S., retired), M.R.C.S. (Eng.). D.P.H. (United Colleges, London). Pathological Investigator. Distinguished for work on Malaria and Kala-azar (Assam). Commenced these special studies in Tropical Hygiene and Parasitology in 1891. Papers on these subjects and on Histology of Blood, Indian Medical Societies and Journals. Parkes Memorial Prize and Gold Medal (Netley) for Essay on Malaria, 1894. Same year commenced experimental examination of Manson's Mosquito-Malaria theory, and studied malaria parasites at Secunderabad. Determined evolution of "crescents" in stomach cavity of gnats (Manson, *Brit. Med. Journ.*, March, 1896). Established animate nature of the flagellate bodies (*ibid.*, Jan., 1897). Finally succeeded in cultivating malaria parasites in gnats (*ibid.*, December 18, 1897; Feb., 1898). Next year elucidated life-history of a malarial parasite (*Proteosoma Grassii*) of birds; infected numerous healthy birds by bites of gnats, thus establishing mosquito theory. Also investigated Kala-azar (Reports to Govt. of India, 1898–99). Appointed Lecturer in Tropical Medicine, Liverpool School of Tropical Medicine, 1899. Continued malaria investigations in Sierra Leone (Report of Liverpool Expeditions, 1900). Author also of Notes on *Amoeba coli* and *Cercomonas intestinalis* (*Indian Med. Gazette*, 1897); Report on Sanitation of Bangalore, 1896. Also contributor to Quain's Dictionary of Medicine), and wrote "Instructions for Prevention of Malaria," 1900 (used by Government).

WILLIAM SCHLICH,

Ph.D., C.I.E., Doctor of Philosophy of the University of Giessen; Companion of the Order of the Indian Empire: Principal Professor of Forestry in the Royal Indian Engineering College, Coopers Hill. Dr. Schlich is well known for the impetus which he has recently given to the study of Forestry in England. Between 1871 and 1880 he was Conservator of Forests in Sind, Bengal and the Punjab successively, and in 1881 he was appointed Inspector-General of Forests to the Government of India. From 1885 to 1889 he was employed specially in England in organising the first English Forest School; and in 1889 he was appointed to his present office. He is a man in thorough sympathy with Science, and has attained great eminence in that branch of it to which he has devoted most of his life-work. Besides his well-known and comprehensive "Manual of Forestry," he is the author of the following papers:—Various Articles on Scientific Forestry, in the *Allgemeine Forst und Jagd Zeitung*, 1864–67; "The Pyinkado Forests of Aracan," 1869; a Series of Reports on the Forests of Bengal and Assam, 1872–75 [in 1875 he was honorary editor of *The Indian Forester*, which is the leading monthly journal of Forestry]; "The Forests of Darjeeling, Central Provinces, Hyderabad Assigned Districts, Chota Nagpore," 1882–85; "Afforestation in Great Britain and Ireland, Yield Tables for the Scotch Pine, the Douglas Fir, Effects of Forests on Climate, Forestry in the Colonies and India" (*Trans. of Colonial Institute*, 1886–89); "Forestry Education" (*Trans. Royal Arboricultural Soc., Scotland*, 1897); "Timber Supply of the British Empire" (*Imperial Institute Gazette*, 1897).

ARTHUR SMITHELLS,

B.Sc. (Lond.), F.C.S. Professor of Chemistry in the Yorkshire College, Leeds. Distinguished for his Investigations on the Chemistry of Flames. Author of the following Papers (among others): "Some Fluorine Compounds of Uranium" (*Journ. Chem. Soc.*, 1883); "Structure and Chemistry of Flames" (*ibid.*, 1892); "Structure of Luminous Hydrocarbon Flames" (*ibid.*, 1892); "Flame" (Discourse to Brit. Assoc., 1893); "Luminosity of Flames" (*Phil. Mag.*, 1894); "The Structure and Chemistry of the Cyanogen Flame" (*Journ. Chem. Soc.*, 1894, with Dr. Dent); "The Luminosity of Gases,"; "Spectra of Copper and Gold Salts" (*Phil. Mag.*, 1895); "Flame Temperatures and the Acetylene Theory of Luminous Hydrocarbon Flames" (*Journ. Chem. Soc.*, 1895); "The Source of Light in Flames" (*Proc. Roy. Inst.*). Has also taken an active part in improving science teaching in schools. Has edited revised edition of Schorlemmer's "Rise and Development of Organic Chemistry," 1894.

M. R. OLDFIELD THOMAS,

F.Z.S., F.R.G.S., M. Anthrop. Inst. Senior Assistant, Zoological Department, British Museum. In charge of the collection of Mammals in the British Museum since 1878, during which period it has increased materially in extent and completeness. Distinguished for his acquaintance with the structure, history and distribution of Mammals. Author of the

"Catalogue of Marsupialia and Monotremata" in the British Museum, 1888. Joint author with Dr. Sclater of "The Book of Antelopes." Author of upwards of 200 memoirs and papers in various journals on Mammals, their structure and distribution, amongst which are:—"On the Dentition of *Ornithorhynchus*" (*Proc. Roy. Soc.*, 1889); "A Milk Dentition in *Orycteropus*" (*ibid.*); "On the Species of *Hyracoidea*" (*Proc. Zool. Soc.*, 1892); "On Cœnoles, a still existing survivor of the *Epanorthidae* (*ibid.*).

WILLIAM WATSON,

B.Sc., Associate, Royal College of Science, London, and Assistant Professor of Physics. Late University Scholar in Experimental Physics, London University. In conjunction with Mr. Boys and Mr. Bristoe he published a paper on "The Measurement of Electro-Magnetic Radiation" (*Phil. Mag.*, 31–44, 1891). In conjunction with the late Mr. J. W. Rodger he published a paper "On the Magnetic Rotation of the Plane of Polarisation of Light in Liquids" (*Phil. Trans. Roy. Soc.*, 1895). This paper represented the results of four years' work. As Secretary of a Committee of the Brit. Assoc. he has, in conjunction with Prof. Rücker, been conducting a series of comparisons between the Magnetic Instruments in use in the British Observatories, and the results have been published in the Report of the Brit. Assoc. He is still at work on an instrument for comparing Thermometers (see his paper, *Phil. Mag.*, 44–116, 1897). He is now engaged in investigating the connection between the magnetic units employed in Observatories and the Ampere and Ohm.

WILLIAM CECIL DAMPIER WHETHAM,

M.A. Lecturer in Physics. Fellow of Trinity College, Cambridge. Author of the following scientific papers, &c.:—"On the Alleged Slipping at the Boundary of a Liquid in Motion" (*Proc. Roy. Soc.*, xlviii., p. 225, 1890, and *Phil. Trans.*, 1890, A., p. 559); "Note on Kohlrausch's Theory of Ionic Velocity" (*Phil. Mag.*, July 1891); "Ionic Velocities" (*Proc. Roy. Soc.*, lii., p. 283, 1893, translated *Zeits. für Physikal Chem.* xi., p. 220, 1893, also *Phil. Trans.*, 1893, A., p. 337); "On the Velocity of the Hydrogen Ion through Solutions of Acetates" (*Brit. Assoc. Reports*, 1894, p. 568): "On the Velocities of the Ions and the Relative Ionisation Powers of Solvents" (*Phil. Mag.*, 1894); "The Velocities of the Ions" (*Proc. Roy. Soc.*, lvii., p. 182, 1895, and *Phil. Trans.*, A., 1895, p. 507); "The Ionising Power of Solvents" (*Phil. Mag.*, July, 1897); "Report to the British Association on the Present State of our Knowledge in Electrolysis and Electro-Chemistry"; "The Theory of the Migration of the Ions and of Specific Ionic Velocities" (*Brit. Assoc. Report*, 1897, p. 227); "The Coagulative Power of Electrolytes" (*Phil. Mag.*, November, 1899); "The Ionisation of Dilute Solutions at the Freezing Point" (a paper read before the Royal Society); an elementary text-book on "Solution and Electrolysis" (Camb. Univ. Press, 1895); Letters and Articles in NATURE and *Science Progress*.

ARTHUR SMITH WOODWARD,

F.G.S., F.L.S., F.Z.S., F.R.G.S., &c. Assistant-Keeper of Geology, British Museum, Natural History, Cromwell Road, S.W. Studied at the Owens College, Manchester, 1880–82; entered British Museum, August 24, 1882; awarded Wollaston Fund by Geological Society, 1889; and the Lyell Medal in 1896. Distinguished for his knowledge of Fossil Fishes. Author of 150 separate papers, mostly on Vertebrate Palæontology: (142 on Fossil Fishes; 14 on Reptilia; 4 on Mammalia; and 14 on General Palæontology). Author of two monographs (1890–95) on the Fossils of the Hawkesbury Series (*Mem. Geol. Survey*, New South Wales (Palæontology), Nos. 4 and 9, Museum, Sydney, New South Wales); and on Fossil Crocodilia from the Cretaceous Rocks of Neuquen, Argentine Republic (*Anales Mus. La Plata*, 1896). Author of a British Museum Catalogue of Fossil Fishes, comprising: Part I. "The Elasmobranchii" (pp. i.-xlvii. and 1-474, plates i.-xvii. and 13 woodcuts, 8vo, 1889); Part II. "The Elasmobranchii" *continued* (pp. i.-xliv. and 1-567, plates i.-xvi. and 58 woodcuts, 8vo, 1891); Part III. "The Actinopterygian Teleostomi" (pp. i.-xliii. and 1-544, plates i.-xviii. and 45 woodcuts. (Printed by order of the Trustees, 1895.) Part IV. now preparing for press. Also "Outlines of Vertebrate Palæontology" (Camb. Univ. Press), 1898, pp. i.-xxiv. and 1-470, with 228 illustrations in the text.

REV. JAMES CHALMERS ("TAMATE").

FEW missionaries have been so widely known and so deservedly appreciated as the Rev. James Chalmers, of the London Missionary Society, whose death has recently been reported. Mr. Chalmers was transferred from Raratonga in the Hervey Group to New Guinea twenty-three years ago, and it is in connection with his later field that he has earned a recognition in scientific journals.

Tamate, as Mr. Chalmers loved to be called by his white as well as by his black friends, was a man of tremendous energy and enthusiasm, and he possessed a rare sympathy with the natives that was due to a deep knowledge of their nature and a personal love for them. His name was a password along very nearly the whole of the southern coast of British New Guinea, and in many places for some distance into the interior. Those natives who had only heard of him longed to see him, those who knew him loved him. Till Sir William Macgregor's arrival he had travelled more in British New Guinea than any other man, and, without appliances, he had increased our geographical knowledge of the possession.

It was always a regret to his scientific friends that Tamate did not publish more about the natives concerning whom he knew so much; but he confessed that he greatly disliked the effort of writing down his experiences, though when he did so he could write in a very vivid manner. His first book, "Work and Adventure in New Guinea" (1885), was written in collaboration with the Rev. Dr. W. Wyatt Gill, to whom anthropologists owe so much. In 1887 Chalmers published his very interesting "Pioneering in New Guinea." In the same year he published a paper "On the Manners and Customs of some of the Tribes of New Guinea" in the *Proc.* Phil. Soc. Glasgow, xviii. p. 56. A valuable "Report on the Toaripi and Korari Tribes" was printed in the *Report Austral. Assoc. Advanc. Sci.* ii. 1890, p. 311. In vol. xxvii. (1897) of the *Journal* of the Anthrop. Inst. he published "Vocabularies of the Bugilai and Tagota Dialects, British New Guinea" (p. 139), "Toaripi" (p. 326), "Anthropometrical Observations on some Natives of the Papuan Gulf" (p. 335). Mr. Chalmers has frequently sent ethnographical specimens to various museums. The bulk of one large consignment was acquired by the British Museum. These objects were carefully labelled and were accompanied by a descriptive catalogue, and many of his labels have been copied by Edge-Partington and Heape in their "Ethnographical Album of the Pacific Islands." These collections contained many specimens and the descriptions much information that was not previously known; for example, the collection included the first bull-roarer obtained on the mainland of British New Guinea.

Mr. Chalmers greatly assisted the Cambridge expedition to Torres Straits by lending his mission boat on more than one occasion, and he hospitably entertained several members of the expedition and otherwise rendered valuable aid.

A noble life of self-sacrifice was laid down for the cause of peace, for, according to the telegram, he met a glorious death while endeavouring to stop a tribal fight on the Aird River, a region which had not yet come under missionary influence and over which the Government had no control. A very promising young coadjutor, the Rev. Oliver Fellows Tomkins, who was dearly loved by Chalmers, and twelve students, are reported to have been murdered at the same time.

Since the above was written a telegram has been received confirming the former rumours. Mr. Chalmers, like several other missionaries in New Guinea, has falsely been reported to have been murdered on more than one occasion; but we fear this time the news is only too true.

A. C. HADDON.

NOTES.

SIR W. ROBERTS-AUSTEN, K.C.B., on leaving the chair as president of the Iron and Steel Institute, at the meeting on Wednesday, announced that Mr. Andrew Carnegie had increased the gift of 6500*l.*, which he made last year to the research fund of the Institute, to 13,000*l.*

AT the recent meeting of the U.S. National Academy of Sciences, Mr. Alexander Agassiz was elected president of the Academy. The Henry Draper Medal was awarded to Sir William Huggins for his work in astro-physics. The following were elected foreign associates:—Dr. J. Janssen, M. Lœwy, director of the Paris Observatory, M. E. Bornet, Prof. Hugo Kronecker, Prof. A. Cornu, Prof. F. Kohlrausch, Sir Archibald Geikie and Prof. J. H. van 't Hoff.

THE movement in Cambridge to secure a portrait of Prof. G. D. Liveing has already received large and influential support. The secretaries think that there are many friends of the professor both in Great Britain and abroad who would like to join in the proposal and who have not yet had notice of it. Such friends should apply to Prof. Lewis, Cambridge, who will be glad to receive their names.

MR. W. LANGDON has been nominated for election as the new president of the Institution of Electrical Engineers. M. Mascart has been elected an honorary member of the Institution.

PROF. ZEILLER, professor of palæobotany at the Paris School of Mines, has been elected a member of the section of botany of the Paris Academy of Sciences, in succession to the late M. Chatin.

A MEETING of the Institution of Mining Engineers will be held in the rooms of the Geological Society, Burlington House, on May 23-25, with Mr. H. C. Peake as chairman. Among the subjects of papers to be read or taken as read are the field-work of photographic surveying as applied in Canada; gold-dredging; the production of copper and its sources of supply; geology of the mineral deposits of the Transvaal; and auxiliary ventilation.

AN expedition against the Anopheles mosquito will be despatched this month to West Africa, under Major Ronald Ross, by the Liverpool School of Tropical Medicine. A leading Glasgow citizen has placed at the disposal of the school and Major Ross a sum of money sufficient to defray the expenses of one year's trial in some malarious city.

A SPECIAL committee has been appointed by the Trinity House, with the deputy-master, Captain G. R. Vyvyan, as chairman, to carry out numerous practical experiments with sound-producing instruments as coast fog signals at St. Catherine's Point, in the Isle of Wight, including comparisons between different forms of sirens and reed instruments sounded by means of compressed air, the observations being made from the Trinity steamer *Irene* at various distances and under varying conditions of weather, &c. The committee will have the advantage of Lord Rayleigh's advice and assistance in the investigations. Representatives of the Admiralty, the Board of Trade, and of the Northern and Irish Lighthouse Boards will also be present.

REFERENCE has frequently been made in these columns to the enlightened and progressive way in which agriculture is carried on in New South Wales and other Australian colonies. Every advantage is taken of modern methods, and the bearings of scientific investigations upon agricultural practice seem to be well appreciated. We are, therefore, not surprised to see in the *Natal Mercury* that Mr. F. R. Moor, Secretary for Native Affairs, who has been on a visit to Australia, has returned to Natal with strong convictions as to the urgent necessity for radical improvements in the methods of agricultural industry in that colony. It is acknowledged that in the past the colony has been depending more upon commercial business as a distributing medium for the interior States than on its productive resources; but the changing conditions demand that the productive capacity should be increased if Natal is to prosper. The obsolete methods of farming now adopted must give place to a system based upon science and carried on with appliances which modern inventive genius has placed at the disposal of agriculture. As Mr. Moor is a member of the Ministry, as well as a farmer of more than average ability, his visit to Australia should not only direct attention to the need for progress in the science and art of agriculture, but also lead to changes which will in the course of time bring Natal into line with other progressive colonies.

THE Board of Trade has given its decision in the inquiry held with reference to the regulation allowing the consumer to veto any change in the pressure at which he is supplied with electric energy. A summary of the evidence given at the inquiry has already appeared in NATURE (vol. lxiii. p. 587). As was generally anticipated the decision now given is in favour of the undertakers depriving the consumer of the absolute power of veto which he has hitherto possessed. In future, when the consumer shall refuse to consent to the change after the undertakers have offered to comply with the conditions laid down by the local authority and to pay the reasonable costs of making the change, the undertakers can appeal to the Board of Trade. The Board may give their consent to the change under such conditions as they may think fit, and this consent shall reckon as equivalent to the consent of the consumer. The Board may, if they consider it desirable, refer to a single arbitrator the question as to what terms and conditions it would be proper to impose, the arbitrator being appointed by themselves.

THE recent conversazione held by the American Institute of Electrical Engineers at Columbia University appears to have been a great success. According to an American contemporary, one of the most interesting exhibits was that made by Mr. P. C. Hewitt, who showed a number of electric vacuum-tube lamps. The lamps consist of glass tubes filled with mercury vapour, through which a current of electricity is passed. The positive electrode is of iron and the negative of mercury. The lamps are arranged to burn directly on the ordinary 100- or 200-volt lighting mains, but they need an extra high voltage to start them, this being obtained by the use of a Wehnelt interrupter or by other suitable means. The light is said to be very steady and brilliant, but poor in red rays; the disagreeable colour due to this defect can, it is stated, be avoided by the use of red reflecting screens. Lamps of 500 and 1000 candle-power were shown burning on the 115-volt direct current mains, the consumption of energy being only half a watt or less per candle. This is much in advance of any other artificial light, and if the lamps can be made commercially in a convenient form and for small candle-powers they should have a great future before them.

WE have received from Dr. J. M. Pernter, director of the Austrian Meteorological Service, an interesting account of the present state of modern "weather-shooting" as practised in Austro-Hungary and Italy—being a reprint of an article contributed to the journal *Die Kultur* (Vienna). The modern experiments were inaugurated by M. Stiger, Burgomaster of Windisch-Feistritz in Steirmark, and the apparatus, consisting of a mortar with a long funnel, was improved by M. Suschnig, of Graz. The theory is that by firing large charges of gunpowder a series of atmospheric rings or whirls are generated and that they penetrate the clouds with sufficient force to prevent the formation of hail, or to disperse it. The idea gained ground so rapidly that, at the present time, there are no less than some 1400 shooting stations in Hungary and many more similar stations in Italy. Dr. Pernter and others were delegated by the Austrian Ministry of Agriculture to witness and report upon the results of experiments as to the efficacy of the system. The experiments were made both in horizontal and vertical directions, with the result that in the horizontal direction the whirls which on leaving the mortar attained a velocity of, say, 170 miles an hour were reduced, at a distance of 80 to 100 metres, to less than 100 miles an hour, and in the vertical direction an initial velocity of 200 miles an hour was reduced to about 75 miles an hour at a height of about 110 metres. It was estimated by Dr. Pernter that the whirls would in no case reach a greater height than 400 metres. The only thing that can at present be positively asserted is that it is not impossible that the shooting may sometimes prevent hail; it is, however, improbable that the energy of the whirls—except under the most favourable conditions—can directly influence its formation.

THE unexpected death of Dr. Kohlstock, which occurred at Tientsin on April 15, causes a great loss to the medical department of the German Army, in which he was regarded as one of the best and ablest organisers. At the time of his death he was forty years of age and was sent, some months ago, to Tientsin, with a view to directing the military hospital there. Prof. Kohlstock will be best remembered in this country by the conspicuous part he played in 1896 in his capacity as Prof. Robert Koch's first assistant during the former's sojourn in South Africa for the purpose of investigating and combating the rinderpest. In Germany, however, his name is associated with several other by no means less important scientific researches. In 1890 he began some special bacteriological studies under the superintendence of Prof. R. Koch, and in the following year the "Seminar für orientalische Sprachen" was founded in Berlin, and Dr. Kohlstock, upon Prof. Koch's recommendation, became lecturer on tropical hygiene at that institute. To his connection, as a teacher, with this institute he mainly owes the title of professor, which was conferred upon him by the German Government in 1898. But his activity and interest were not confined to this work alone, indeed his subsequent appointment as a scientific adviser to the German Foreign Office in matters bearing upon tropical hygiene very largely increased his usual work and brought him into public prominence, with the result that he was soon requested by several private colonial associations to accept a post similar in character to that he held in connection with the Foreign Office, but he declined these offers. His scientific and literary contributions are numerous, but they are entirely devoted to the domain of clinical and bacteriological research in connection with malaria and yellow fever. One popular book, however, which he wrote about two or three years ago is likely to survive him for some time to come, namely, his "Aerztlicher Rathgeber für Ost-Afrika und andere tropische Malaria-Gegenden." Lastly, in conjunction with Prof. Koch he originated the scheme for the establishment of the so-called "Deutsche Anstalt für Tropen-Hygiene," which was recently erected in Hamburg.

MR. J. H. HART'S Annual Report on the Royal Botanic Gardens of Trinidad for the year 1900 deals, as usual, with the botanical and meteorological work in the Gardens, and also the monthly rainfall statistics at some scores of points of observation throughout the island. Several seismographic records were supplied to Prof. Milne, the most important being that of the Caracas earthquake of October 29, the shock commencing suddenly, without any preliminary tremors, and agitating the instrument for two hours. In the herbarium several fungi and parasitic insects injurious to vegetation were under investigation, and also a disease occurring in the cacao plantations of Surinam. A course of agricultural education for elementary school teachers having been inaugurated appears to have proved highly successful, four courses being attended by 112 teachers and 10 cadets. Sugar cane experiments were confined to the raising and trial of new seedlings, and the cultivation of small areas of a few standard kinds for control purposes, no manurial experiments being attempted. From May 1899 to May 1900 there were 170 new canes analysed, 131 being Trinidad seedlings, the rest Demerara, Barbados and standard kinds. The question of the pollination of the cane by wind or insects is still unsettled, but it is found that the greatest variety and the best kinds of canes come from seed harvested where several distinct varieties are planted closely together. Notes are given on the experimental cultivation in the Gardens of rubber, nutmegs, coffee, oranges, guava and other plants. Botanical officials in other West Indian islands supplied as many as seventy varieties of sweet potatoes, but in all cases their yield was very poor.

IN his natural history notes Mr. Hart states that in the St. Ann's and Maraval rivers two species of small fish are found, one not so large as the English stickleback, the other slightly larger. They are commonly found in garden fountains and tanks, and both destroy the larvæ and eggs of mosquitoes. The question of the benefit of introducing these or similar fish into noted malarial districts is well worthy of consideration. It is a fact that the common gold-fish or carp does not increase in their presence owing to the smaller fish devouring the eggs of the larger. Gold-fish, however, are said to destroy mosquito eggs and larvæ. The study of living specimens of insects is rendered difficult by the behaviour of small ants, which attack and destroy nearly every form of insect. All experiments have, therefore, to be conducted in receptacles standing above water. In tapping Para rubber trees it is found that some of the coagulated rubber is cut up and carried away by a large species of black ant. Species of bees, genus Trigona, have also been observed carrying off the coagulated rubber fluid from the stems of *Castilloa elastica*. Similar species use resinous exudations from the *Garcinias* and other trees as ready-made wax for their nests, and in some cases actually cut the bark in such a manner as to cause a flow of the desired fluids.

THE April number of the *Journal of the Franklin Institute* contains the first part of a paper by Mr. Edwin Swift Balch, entitled "Antarctica: a History of Antarctic Discovery." In the introduction to his paper, the author says—"Not long since Sir Clements Markham proposed in the *Geographical Journal*, for November, 1899, to divide the Antarctic into four quadrants, each covering 90° of longitude, and to bear English names. The advantages of this proposition on the score of convenience are not self-evident. Moreover, it is only just to remember that, besides Englishmen, mariners of many other nations have made discoveries in the Antarctic. A letter that I wrote on this matter was published in the *Nation*, New York, May 10, 1900, and also in the *Evening Post*, New York, of the same date. Up to that time I had made no special study of Antarctic geography, and discovered then how difficult it was to find accurate data." In the present instalment the author covers, with considerable detail, (*a*) Voyages leading from a belief to a disbelief in a Terra Australis Incognita, and (*b*) Voyages up to the discovery of a South Polar Continent.

SIR MARTIN CONWAY has drawn up, in the form of a pamphlet entitled "The Rise and Fall of Smeerenburg, Spitsbergen," and privately printed, the results of much careful and laborious investigation into the history of the rival fisheries carried on in Spitsbergen during the seventeenth century. In 1614 the Noordsche or Greenland Company, which had obtained the monopoly of the whale fishery for the Dutch Republic, sent up a force "which the English, under Captain Joseph, were too weak to drive away." They sent some ships to Fairhaven, and probably settled on Amsterdam Island on the flat ground at its south-east angle, the site of the future Smeerenburg, or Blubbertown. Sir Martin Conway traces, so far as they can be traced, the fortunes of Smeerenburg, from its rise in the manner described, to its fall, or rather through its decline, when the whales began to find Fairhaven too dangerous for them. They "began to be shy of the Cookeries and anchorages of the ships, shallops, and what pertained to them; next of the bays, and then of the shallows along the coast, where they were constantly pursued," apparently about 1639; in 1646 "the season was only opened off Smeerenburg, and the whales were then followed to sea or along the north coast." By 1650 the whales had abandoned the banks and Smeerenburg became valueless as a place for trying-out the train-oil. As late as 1671 it remained a place of refuge for refitting ships, but twenty years later nothing was left but the foundations of a few houses. Sir Martin Conway gives many useful references to cartographical and other authorities, and adds a section on the topography and nomenclature of Fairhaven and its neighbourhood.

THE Geological Survey of India has attached to its staff as "Mining Specialist" Dr. F. H. Hatch, who has lately reported on the Kolar gold-field in Mysore (*Memoirs*, vol. xxxiii. part 1, 1901). The auriferous lodes consist of a series of parallel quartz veins in the Dharwar schists, and they conform generally to the direction of the foliation planes of these rocks. They are therefore regarded as "bedded veins," formed by the deposition of quartz and other minerals from solution along open channels or planes of weakness which in general coincided with the foliation of the schists. To this fact is ascribed their lenticular character; they swell and pinch at irregular intervals. As a rule, gold is not visible in the hand-specimens of quartz, which is of a dark bluish-grey colour. In places the quartz has been subject to great stress consequent on the bending of the vein into acute folds, and there it has a well-developed banded or laminated structure. Along the axes of the folds, where the vein is doubled back on itself, large and valuable bodies of ore are found; and where slickensides have been formed by differential movements in the vein, the gold sometimes occurs as a fine film on the smoothed and polished surface. Dr. Hatch deals exhaustively with the methods of working and production of this gold-field.

THE two leading formulæ at present in use in performing interpolations by central differences are due to Newton. In a note reprinted from the *Journal* of the Institute of Actuaries, xxxv. p. 452, Prof. Everett proposes a new formula containing only even differences, which appears to be very simple and convenient.

M. PELLAT contributes to the *Journal de Physique* (April) a short note on the laws of nature in which he points out, as a consequence of the principle of degradation of energy, that, as applied to the universe, the notion of infinite time necessitates that of infinite space.

MR. J. A. THIRD contributes to *Mathesis*, 1900, a short note on trihomologous triangles. Such triangles have three centres of homology, in each of which the lines joining the vertices of one triangle to those of the other are concurrent, the three centres being got by joining different vertices taken in order. They therefore have three axes of homology, on each of which lie the three points of intersection of three sides of the one with three sides of the other. The theorems now proved relate to certain conics connected with the two triangles and lead to a number of particular cases including certain properties of Steiner's ellipse.

TO the May issue of the *Entomologists' Monthly Magazine* Sir George Hampson contributes a long list of abnormalities among Lepidoptera, as illustrated by a series of specimens recently presented to the British Museum by Mr. South, who had spent many years in collecting them.

DR. C. S. MINOT sends us a copy of "Notes on Anopheles," which recently appeared in the *Journal* of the Boston Society of Medical Science (vol. v. p. 325). They are based upon observations made upon the larvæ of these mosquitoes by the author so long ago as 1879, and are illustrated by excellent figures of the larvæ and pupæ of Anopheles and Culex. These observations, it is believed, are the earliest which have been made on the first stages of the life-history of the two insects, and accord well with those recently recorded by other writers.

To the same author we are indebted for a report (from *Science*) of his Middleton Goldsmith lecture delivered before the New York Pathological Society on March 25. The subject is the embryological basis of pathology, the lecturer claiming that a scientific study of pathological phenomena is in a greater degree a superstructure upon embryology than it is upon anatomy. "The fundamental problems of pathology and embryology are," it is urged, "alike, not only in being problems of cell life, but also in being similar and even identical problems of cell life. Widely as the two sciences differ, they rest on a common foundation."

WE have received information of the occurrence of a considerable landslip in Danby Dale, a deep valley drained by a tributary of the Esk in the moorlands of East Yorkshire, about seven miles west of Egton. The region is one in which many landslips have from time to time occurred, owing to the undermining

and breaking away of the Dogger and Lower Estuarine Sandstones and Shales which overlie the Alum Shale. In the present instance, the slip appears to have affected about sixty acres of ground, while the fissure along which the subsidence took place extended for a distance of more than half a mile. The fall represented in the accompanying picture, reproduced from a photograph taken by Mr. George A. Macmillan, is about ten or twelve feet high. The fissure at the foot was filled with snow when the photograph was obtained.

A BEAUTIFUL coloured plate illustrating the remarkable resemblance presented to their inanimate surroundings by certain spiders forms the most attractive feature of vol. xxxi. part 2 of the *Travaux* of the Imperial Society of Naturalists of St. Petersburg. It accompanies an article, by Dr. W. A. Wagner, on colouring and mimicry among animals, of which there is a summary in German, the full text being in Russian. In several instances the spiders are represented on lichen-clad bark, the resemblance being most remarkable in the case of a species of Epeira on very dark bark shown in Fig. 7. Still more curious is a blue spider of the same genus nestling amid a rosette of azure lichen. Other examples show white or yellow spiders in flowers of similar colour, the resemblance being most complete in the case of a Vatia, whose yellow body is spotted with red to accord with a yellow and red flower. After tracing the gradual evolution of this type of "mimicry" among spiders from the dull-coloured to the bright-hued species, the author refers to certain well-known difficulties as to the origin of resemblances of this nature.

A LARGE Mycenæan *pithos* in the First Vase Room, British Museum, was inadvertently stated on p. 13, col. 1, line 6 from bottom, to have come from Ialysos in Rhodes. In reality it was brought from Knôssos itself by Mr. Minos Kalochairinos, who essayed several excavations at Kephala in years gone by.

WE learn, from the *Journal of Botany*, that a new society, to be called the International Botanical Association, is to be inaugurated at a meeting to be held in the botanical laboratory of the University of Geneva on August 7. The chief object of the Association will be "the foundation of a bibliographic periodical, criticising in a perfectly impartial manner all botanical publications. . . . The criticisms will, at the desire of the contributors, be published in English, French or German." The editor, who will be responsible to the Association for this absolute impartiality and the cyclopædic knowledge which it involves, will be Dr. J. P. Lotsy, of Wageningen, Holland; and the subscription to the Association, including the periodical, is not to exceed 25*s.* per annum.

THE first volume of a "Handbuch der systematischen Botanik," by Prof. R. R. v. Wettstein, has been published by Herr Franz Deuticke, Leipzig and Vienna. The chief object of the work is to present a view of the various forms of plants, with special reference to their phylogenetic development. The volume just received contains an account of the principles of systematic botany and of different plant systems, and a description of the characteristics of six great divisions of the plant kingdom, distinguished as follows:—myxophyta, schizophyta, zygophyta, euthallophyta, phaeophyta and rhodophyta. The cormophytes are reserved for treatment in the second volume, which will appear in the course of next year, when the two volumes will be noticed together.

THE additions to the Zoological Society's Gardens during the past week include three African Sheep (*Ovis aries*) from Bida Nigeria, a Bateleur Eagle (*Helotarsus ecaudatus*) from Zebba Nigeria, presented by Mr. Fanshawe Abadie; a Lion (*Felis leo*, ♂) from Africa, presented by Mr. Rowland Ward; a Chough (*Pyrrhocorax graculus*), British, presented by Mr. W. H. St. Quintin; a Black-pointed Teguexin (*Tupinambis nigropunctatus*) from South America, presented by Mr. G. P. Ogg; a Turkish Gecko (*Hemidactylus turicius*) from Western Asia, presented by Miss Kensington; six Ceylonese Terrapins (*Nicoria trijuga*), a Changeable Lizard (*Calotes versicolor*) from India, three Blue-tongued Cyclodus (*Tiliqua scincoides*), three Black and Yellow Cyclodus (*Tiliqua nigro-luteus*) from Australia, a Chained Snake (*Coluber catenifer*) from California, two Ten-lined Snakes (*Contia decemlineata*) from North America, two —— Snakes (*Contia rothi*) from Syria, four Lacertine Snakes (*Coelopeltis monspessulana*), four Vivacious Snakes *Tarbophis follax*), an Æsculapian Snake (*Coluber longissimus*), a Dahl's Snake (*Zamenis dahli*), two Dark Green Snakes (*Zamenis gemonensis*), a Common Snake (*Tropidonotus natrix*, var.) two Glass Snakes (*Ophiosaurus apus*), South European, two —— Ground Snakes (*Typhlops vermicularis*) from Asia Minor, a Black-necked Stork (*Xenorhynchus australis*) from Malacca, deposited; two Smews (*Mergus albellus*), a Velvet Scoter (*Ædemia fusca*), four Wigeon (*Mareca penelope*), European, purchased.

OUR ASTRONOMICAL COLUMN.

COMET *a* (1901).—A further telegram concerning the new comet has been received from Kiel announcing its observation at Arequipa, in Peru, on May 2, at 6h. 48·6m. p.m. Its position then was

$$\text{R.A.} = 3\text{h. } 30\text{m.}$$
$$\text{Decl.} = -1^\circ\ 0'.$$

A later telegram gives particulars of another observation at the Cape at the position

$$\left.\begin{array}{l}\text{R.A.} = 3\text{h. } 54\text{m. } 29\text{s.}\\ \text{Decl.} = -0^\circ\ 18'\ 27''\end{array}\right\}\ 1901 \text{ May 4d. 6h. } 28{\cdot}8\text{m.}$$

Daily Motion in R.A. = + 14m.
,, ,, Decl. = + 13′.

It has been observed at Eastbourne by Mr. Chambers, who saw it about 3.0 a.m. on May 2. Reports in the daily Press also state its frequent observation at Melbourne and the Cape, but its motion is there stated to be north-westerly.

STELLAR PHOTOGRAPHY WITH A SIDEROSTAT.—Some little interest has been evinced during the past few months in connection with the practical elimination of the rotation of the field which occurs when a siderostat is used to follow the diurnal motion. In *Comptes rendus* (vol. cxxxii. pp. 931–932) Prof. Lippmann suggests a mechanical contrivance, to be attached to the slide carrying the photographic plate, which shall be so geared to the driving mechanism of the siderostat itself as to compensate for the rotation of field.

Prof. Cornu, in the same number, pp. 1013–1017, calls attention to a method he has previously recommended and which he thinks very good as regards mechanical efficiency. The essential factor is the employment of a universal joint, the angle between the component axes depending on the polar distance of the direction of the reflected beam. The plate holder is rotated by means of a subsidiary mechanism through the medium of the joint. He was led to the device by having to design a mechanism to represent a formula in connection with polarised light in isotropic and other media, this formula being of the same type as that showing the rotation of field of a siderostat.

From Prof. Cornu's suggestions M. Gautier constructed the necessary apparatus for this purpose, which is used with the 50-inch refractor shown at the Paris Exhibition of 1900.

FORMULÆ FOR VARIATION OF LATITUDE.—The observations of latitude made by Profs. Doolittle and Gratchof (*Astronomical Journal*, Nos. 490 and 495) lead Prof. S. C. Chandler to consider that they afford evidence of changes in the annual component of latitude variation; he therefore proposes to include such changes in the numerical theory, and gives formulæ and tables of reduction which may be used for such observations (*Astronomical Journal*, No. 495).

POSITION OF NOVA PERSEI.—Prof. E. C. Pickering gives, in the *Astronomische Nachrichten* (Bd. 155, No. 3706), the following mean position adopted from numerous measures with the transit circle at Harvard College Observatory:

$$\left.\begin{array}{l}\text{R.A.} = 3\text{h. } 24\text{m. } 28{\cdot}10\text{s.}\\ \text{Decl.} = +\ 43^\circ\ 33'\ 54''{\cdot}8\end{array}\right\}\ (1901{\cdot}0).$$

PHOTOGRAPHS OF THE ZODIACAL LIGHT.—In *Popular Astronomy* for April Mr. A. E. Douglass, of the Lowell Observatory at Flagstaff, Arizona, describes some successful photographs of the western zodiacal cone which he was fortunate enough to obtain on February 13 of this year.

The lens he employed was made in 1899 by Messrs. Alvan Clark and Sons especially for this purpose; its aperture is 0·9 inch, focus 1·8 inches, the intensity being thus 1:2.

Previous to this date many exposures had been made of an hour or more, but the short exposure tried on the 13th was most successful. It appears that when the zodiacal light is at its best, exposures of about eight minutes are ample; when not so clear, about thirty minutes should suffice. Glycin or hydroquinone were found most trustworthy for development, the former being especially free from any tendency to produce general fogging of the plate. Reproductions from three of the photographs taken at intervals of a few minutes accompany the paper. They all show some trace of condensation about the centre of the illuminated cone.

FOG FORMATIONS.

BRIEF reference has already been made (vol. lxiii. p. 161, December 13, 1900) to some interesting observations and photographs of fog made by Mr. A. G. McAdie on Mount Tamalpais, a little to the north of San Francisco. Several articles upon the subject have been contributed by Mr. McAdie to the U.S. *Monthly Weather Review*, and the particulars given below have been derived from one in the issue of November, 1900. We are fortunate in being able to reproduce one of Mr. McAdie's striking photographs of fog, through the courtesy of Prof. Cleveland Abbe.

Fog is very prevalent on the central coast of California, especially in the vicinity of the Bay of San Francisco. The topography of the district is remarkable, because of the close juxtaposition of ocean, bay, mountain and foothill. A valley, level as a table, 450 miles long and 50 miles wide, having afternoon temperatures of 100° or over, is connected by a narrow water passage with the Pacific Ocean, the mean temperature of the water in this locality being 55°. Thus within a distance of 50 miles in a horizontal direction there is frequently a difference of 50° in temperature, while in a vertical direction there is often a difference of 30° in an elevation of half a mile. High bluffs, ridges and headlands are at such an angle to the prevailing strong westerly surface air currents that an air stream is forced with increased velocity through the Golden Gate, and there must of necessity be considerable piling up of both air and water vapour at this point. The locality may indeed be considered as a natural laboratory, in which experiments connected with cloudy condensation of water vapour are daily wrought, and it is therefore of more than passing interest to the meteorologist.

Much faithful work has been done in physical laboratories on the behaviour of water vapour at varying volumes, pressures and temperatures. Regnault, Thomson, Broch, Aitken, Kiessling, R. von Helmholtz, Hertz, Rayleigh, von Bezold, Barus, Marvin and others have worked upon the change of state from vapour to liquid and from liquid to solid, and while many irregularities are noted in the behaviour of water vapour, the general problems of decreasing volumes and increasing pressures until condensation points are reached have been solved; and it is well understood that the vapour-liquid and liquid-solid condensations are in themselves but two phases in a chain of condensation phenomena. The problem of fog is therefore a limited one. It may be considered as a special case of cloud development, occurring in the first and second stages of Hertz, viz., the unsaturated and saturated stages. Condensation in the free air, as in these fog formations, takes place under conditions different from those obtaining in the laboratory. There are no fixed restraining walls, though the strongly stratified outlines suggest sharply limited air streams. Again, saturation as it occurs in free, constantly changing air and true adiabatic saturation are not identical. Saturation in the free air must be studied in disadvantageous circumstances, for the work must be done at a distance, with instruments neither sufficiently delicate nor accurate, and there is no control of conditions possible.

An attempt has been made at the Mount Tamalpais station to correlate the surface pressure conditions with fog. There are, however, many different types of fog. The conditions prevailing in winter, when tule fog, formed in the great valleys, drifts slowly seaward, are very different from those prevailing in summer, when the sea fog is carried inland. A typical pressure distribution accompanying sea fogs has been recognised. In general, a movement southward along the coast of an area of high pressure in summer means fresh northerly winds and high temperatures in the interior of the State, with brisk, westerly winds, laden with fog, on the coast.

Direct cooling by contact or radiation is shown by von Bezold to be more efficient as a cause of rainfall than cooling by mixture, but in the production of fog it is probable that cooling by mixture (except in the case of ground fogs) is the most important factor to be considered. It is to be noted that reverse pressures should also be studied, for perhaps a close watch upon the conditions prevailing when fog is rapidly dissipating might conversely throw light upon the order and relative importance of the three ways of cooling, viz., mixture, expansion and radiation.

Von Bezold's deductions may be thus summarised: More vapour condenses when a stream of air and vapour at low temperature impinges on a mass of warmer air than with reversed conditions. Ocean fogs, as a rule, form when cool air flows over warm, moist surfaces, but in the case under discussion, where the ocean surface temperature is 13° C. (55° F.) and the air temperature may reach 27° C. (80° F.), it is evident that the above does not hold. It is more probable that condensation is the result of the sharp temperature contrasts at the boundaries of certain air currents having different temperatures, humidities and velocities, and that the contours of the land play an important part in the originating and directing these air currents. The summer afternoon fogs of the San Francisco Bay region, then, are probably due to mixture more than radiation or expansion. The winter tule fogs of the Sacramento and San Joaquin valleys are probably pure types of radiation fog, where the process of cloud building is from the cooled ground upward. Occasionally in summer, when the warm air has been pumped out of the valleys and there is rapid radiation, ground fog forms. An illustration of this is given in the accompanying figure, where fog covers a number of valleys.

FIG. 1.—Lifted fog. Height above the ground, about 500 metres. View from U.S. Weather Bureau Observatory, Mount Tamalpais.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. Townsend, the new Wykeham professor of physics, delivered an inaugural lecture at the Clarendon Laboratory on Friday, April 26, upon the recent developments of electro-optics.

Mr. N. V. Sidgwick, of Christ Church, has been elected to an official Fellowship in Natural Science (Chemistry) at Lincoln College.

Mr. A. S. Hunt has been elected to a research fellowship at Lincoln College in order to enable him to prosecute his researches upon Egyptian papyri.

The degree of D.Sc. has been conferred upon Prof. A. H. Church, F.R.S., in recognition of his contributions to chemical and mineralogical science.

No honorary degrees will be conferred at the Encænia this year.

Mr. J. L. Myres and Dr. H. R. Mill have been appointed examiners for the newly-instituted diploma in geography.

The following grants have been made from the Craven University Fund:—100*l*. to Mr. D. G. Hogarth to enable him to continue his researches in Crete; 80*l*. to Mr. T. Ashby towards the cost of publishing the results of his researches in the Campagna Romana.

Mr. J. Passmore Edwards has given to the University the sum of 1675*l*. for the promotion of the study of English literature in its connection with the classical literatures of Greece and Rome.

Scholarships in natural science are advertised for Merton College, New College and non-collegiate students on June 18.

The new Radcliffe Library (presented to the University by the Draper's Company) and the new Pathological Laboratory are approaching completion. The latter and the pathological collections deposited in the University Museum will be, probably, placed under the charge of the reader in pathology, Dr. Ritchie.

The Junior Scientific Club held their 224th meeting on Wednesday, May 1. The papers read were: "Experiences in South African Hospitals," G. H. H. Almond (Hertford); "Organic Compounds of Phosphorus," S. P. Grundy (Balliol).

CAMBRIDGE.—The new Board of Agricultural Studies in their annual report give a favourable account of their first year's working. The number of students attending the special courses of instruction is thirty-nine. The experimental farm is in working order, and no less than thirty-two special experiments on crops, stock, manures, &c., are being conducted in various local stations at the instance of neighbouring county councils. The Board of Agriculture has this year made a grant of 1000*l*. in aid of the work of the department. The special examination in agricultural science for the B.A. degree, and the examinations for the University Diploma in Agriculture, begin on May 29 and extend to June 8.

The Vice-Chancellor will represent the University at the meeting of universities and learned societies in connection with the millenary commemoration of King Alfred the Great at Winchester, to be held this summer.

Prof. Allbutt and Prof. Sims Woodhead will represent the University at the British Congress on Tuberculosis to be held in London next July.

THE following external examiners, among others, have been appointed by the Council of the University of Birmingham. We notice with regret the absence of Astronomy from the subjects. Mathematics, Prof. Horace Lamb, F.R.S.; Physics, Prof. J. J. Thomson, F.R.S.; Chemistry, Prof. H. McLeod, F.R.S.; Zoology, Dr. S. F. Harmer, F.R.S.; Botany, Prof. Reynolds Green, F.R.S.; Geology, Prof. T. G. Bonney, F.R.S.; Anatomy, Prof. Alex. Macalister, F.R.S.; Physiology, Prof. J. G. McKendrick, F.R.S.; Pathology, Prof. G. Sims Woodhead; Medicine, Dr. Donald MacAlister; Public Health, Dr. George Reid.

THE Association of American Universities has recommended the fourteen universities in the United States to extend the Christmas vacation every year to include the first week in January, in order to permit scientific men to attend annual meetings then instead of in the summer. *Science* says: "Columbia University has the honourable distinction of being the first to adopt the important innovation, and has already changed its calendar for 1901–1902, setting free the week of January first for convocation purposes. It is expected that several other universities also will soon announce their adherence to the plan, and it is hoped that in a short time the majority of American and Canadian universities will adopt the recommendation under consideration."

THE Technical Education Board of the London County Council is offering for competition five senior county scholarships of the value of 60*l*. a year for three years, together with payment of tuition fees up to 30*l*. a year. The scholarships are open to young men and young women who are resident within the administrative County of London, and whose parents are in receipt of an income not exceeding 400*l*. a year; and they are tenable at Universities, University colleges, or technical colleges, whether in England or on the Continent. Candidates must be under twenty-two years of age on May 1, preference being given to those who are under nineteen years of age. In addition to the senior county scholarships the Board offers a limited number of free places at University College, King's College and Bedford College, London. The scholarships and grants of free places are awarded, not on the result of an examination, but on a consideration of the past record and achievements of the candidates. Application forms may be obtained from the secretary of the Technical Education Board, 116, St. Martin's Lane, W.C., to whom they should be returned not later than Monday, May 13.

THE Education Bill of the Government was introduced into the House of Commons on Tuesday, and was read a first time. The object of the Bill is to establish in every part of England and Wales a local education authority for the supervision of educational work of all grades; and it is hoped that this authority will ultimately have control over all schools within its area of influence, whether elementary, secondary or technical. The proposal of the Government is to make county and borough councils, acting through statutory committees, the educational authorities, and it is hoped that small counties will combine to form an education area. The new education committee will have no power of rating, but will merely spend the money placed at its disposal by the county council. This money will be derived chiefly from the local taxation receipts, so that the committees will become the successors of those at present responsible for technical instruction. A county council will also have the power of levying a rate, limited to 2*d*., either upon the whole county or upon any part of it for which it might be desirable to make provision, and the sum so raised will be entrusted to the education committee. School Boards and School Board rates are not touched by the Bill, but their ultimate absorption by the new educational authorities is contemplated.

THE Report of the U.S. Commissioner of Education for the year 1898–99 has been received. Much of this bulky volume is taken up with tables referring to the condition and progress of various branches of education, but there are also a number of interesting articles and summaries. A detailed statistical account is given of the institutions for higher education in the United States. A table is given showing the number of students in higher education to every million persons in the United States. In the year 1872 there were 852 of such students to 1,000,000 people, and in 1898–99 the proportion had risen to 1874 college students per million. In the year 1898–99 the total number of students in collegiate, graduate and professional departments of institutions for higher education and in professional schools was 147,164, of which 43,913 were enrolled as professional students in law, medicine and theology, leaving 103,251 students reported as pursuing studies in the liberal arts and applied science. The number of degrees conferred on men after passing through a recognised course was 10,794, and on women 4293. The total value of property possessed by institutions for higher education amounted to more than seventy million pounds. The endowment funds amounted to thirty-one million pounds, and the remainder represented the value of grounds, buildings, &c., used for instruction and research. The total income for the year covered by the report, excluding benefactions, amounted to about six million pounds. The gifts and bequests reported as having been received during the year reached the magnificent total of nearly five million pounds.

WE are glad to notice another movement for the extension of facilities for higher education. A short time ago a council was formed to consider the possibility of establishing a University College for North Staffordshire, and to promote interest in the educational needs of the district. The executive committee now report that the chairman of the council, Mr. Alfred S. Bolton, has purchased, as a site for the College, about three acres of land in a good position at Stoke-on-Trent, and has thus given generous aid to the educational cause of North Staffordshire. Principal Oliver Lodge has become a vice-president of the council in order to show that the scheme has the sympathy and good wishes of the University of Birmingham. It was pointed out by the committee which first started the inquiry into higher education in North Staffordshire that "The nature of the local industries demands special scientific instruction of a more systematic and thorough character than is at present provided anywhere in the district, and foreign competition by nations recognising the practical advantages of such instruction will prove disastrous to the district if the matter is continually neglected." The district is at present remarkably deficient in opportunities for higher education. With a population approaching half a million within easy reach of the centre, there is no institution where young people who have left the secondary school can obtain higher instruction nearer than Manchester (thirty-seven miles) or Birmingham (forty-five miles). Evidently there is room for further provision of educational facilities by the establishment of an institution of the rank of a University College; and it is satisfactory to know that another locality is being aroused to a sense of its educational deficiencies.

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, April, 1901.—Prof. F. N. Cole opens with an account of the proceedings at the February meeting of the Society in New York City, and, in addition to the titles of the nineteen papers communicated, gives an abstract of several of them. Three of the papers are printed. Their titles are: (1) Green's functions in space of one dimension, by Prof. M. Bôcher. The results arrived at are given, but the proofs and further developments are reserved; (2) Possible triply asymptotic systems of surfaces, by Dr. L. P. Eisenhart. This supplements a note by the author, in the January *Bulletin*, entitled, "A demonstration of the impossibility of a triply asymptotic system of surfaces." Instead of the general negation previously given, the author now gives the qualified one: The only triple systems of surfaces cutting mutually in the real asymptotic lines of these surfaces are composed of properly associated families of hyperboloids of one sheet and hyperbolic paraboloids; (3) Note on Hamilton's determination of irrational numbers, by Dr. H. E. Hawkes. The purpose of the note is to call attention to Hamilton's use of the partition (Schnitt) in his definition of certain irrational numbers (*Trans.* of the R. Irish Academy, vol. xvii. 1837, p. 293).—On a system of plane curves having factorable parallels, by Dr. V. Snyder, was read before the December meeting of the Society. The type of scrolls contained in a linear congruence, and having factorable asymptotic lines, gives rise to a class of plane curves whose parallels have a similar property (cf. a paper by the author, in the *American Journal of Mathematics*, vol. xxiii., on a special form of annular surface). Mr. Bromwich gives a very useful analysis of Dr. P. Muth's "Theorie und Anwendung der Elementartheiler" (1899, xvi. and 236 pp.), and hopes that the book may induce its readers to take up the special part of invariant theory treated in it. Mr. Bromwich has done good work in this direction (see *Proc.* of London Math. Soc. vol. xxxii. 1900, p. 98), where he gives a list of papers on the subject.—Short notices follow of Dr. R. Fricke's "Kurzgefasste Vorlesungen über Verschiedene Gebiete der höheren Mathematik, mit Berüchsichtigung der Anwendungen" (1900), and Dr. R. Böger's "Ebene Geometrie der Lage" (1900), both by Prof. H. S. White.—The notes are very copious and interesting, giving account of the courses of lectures in the Continental and home Universities, and the usual new publications close the number.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 28.—"A Preliminary Account of the Development of the Free-swimming Nauplius of *Leptodora hyalina* (Lillj.)." By Ernest Warren, D.Sc. Communicated by Prof. Weldon, F.R.S.

March 14.—"On the Preparation of Large Quantities of Tellurium." By Edward Matthey, A.R.S.M. Communicated by Sir George Stokes, Bart., F.R.S.

March 28.—"On the Enhanced Lines in the Spectrum of the Chromosphere." By Sir Norman Lockyer, K.C.B., F.R.S., and F. E. Baxandall, A.R.C.S.

In the recently published account (*Ast. Phys. Journ.* vol. xii. p. 307, 1900) of the spectroscopic results obtained by members of the expedition from the Yerkes Observatory during the solar eclipse of May 28, 1900, Prof. Frost claims to have established a close relationship between the bright lines in his eclipse spectra and the stronger lines of the Fraunhofer spectrum, and states that "61 per cent. of the latter were measured as bright on the plates."

He also states that "these plates give no evidence of any relationship between the bright lines and the 'enhanced' lines, or lines distinctly more intense in the spark than in the arc spectrum, although Sir Norman Lockyer has attached much significance to a supposed connection between them." He quotes specially the cases of titanium and iron lines, and of 48 enhanced lines of the former element acknowledges that 29—or 60 per cent.—correspond with lines in his eclipse spectra

The authors of the present paper show that if a difference of 0·3 tenth-metres be allowed between the wave-length of an eclipse line and that of the corresponding metallic line (and in some cases Prof. Frost accepts a difference of 0·35 or more between his adopted wave-length and Rowland's wave-length of the corresponding Fraunhofer line), there are 38 of the 48 enhanced titanium lines—or 80 per cent.—which have corresponding lines in the eclipse spectra, thus showing a closer relationship between the enhanced lines of titanium and the eclipse lines than that claimed by Prof. Frost between the latter and the stronger of the Fraunhofer lines.

To show the difference in behaviour in the eclipse spectra of the enhanced and unenhanced lines, several tables have been compiled. The first contains all the Fraunhofer lines in the region covered by Frost's eclipse spectra which have an intensity of 2 or greater, and which Rowland has ascribed to titanium only. These are 53 in number, 20 are enhanced lines and 33 are not. The comparison table indicates that 19 of the 20 enhanced lines have corresponding lines (nearly all prominent) in the eclipse spectra, the remaining one being probably masked by $H\gamma$. Of the 33 unenhanced lines, 23—or 70 per cent.—do not correspond with eclipse lines. Of the nine eclipse lines which do agree in position with unenhanced titanium lines, three are nearly certainly due to other metals, and the remainder are lines of insignificant intensity.

The second table gives the enhanced lines of titanium which are recorded by Hasselberg in the arc spectrum, and a comparison is made with Frost's eclipse lines. This table shows that though the "arc" intensities of the enhanced lines vary from 2 to 7 (max. = 8), they have nearly all corresponding lines in the eclipse spectra, the majority of the latter being quite prominent.

The third table contains all the strongest lines (Int. 7 and 8) in Hasselberg's list of arc lines which are unenhanced. It is shown that only 7 out of 20 have corresponding eclipse lines. To three of these Frost gives no origin, to the others he gives compound origins, three of them involving titanium. In no case is the eclipse line as strong as the majority of those which are the representatives of the enhanced lines.

In the case of iron a similar analysis is given, but only over a limited region of the spectrum (λ 4500 to λ 4600) owing to the great number of lines in the iron spectrum. The same results are arrived at, viz., that the enhanced lines, though insignificant in the iron spectrum so far as intrinsic intensity is concerned, are, in the main, represented in the eclipse spectra by lines of abnormal intensity, whereas many of the stronger iron lines are either not represented at all, or only by weak lines.

"On the Arc Spectrum of Vanadium." By Sir Norman Lockyer, K.C.B., F.R.S., and F. E. Baxandall, A.R.C.S.

In this paper the authors give a list of lines in the arc spectrum of vanadium which have been measured from photographs taken at Kensington with a Rowland concave grating of 21½ feet focus and 14,438 lines to the inch. The region of the spectrum investigated extends from λ 3887 to λ 4932. The sources of the spectrum were (1) vanadium chloride, and (2) a pure sample of vanadium oxide supplied by Sir Henry Roscoe. These were volatilised in the arc between poles of the purest silver obtainable, and which were furnished by Sir W. C. Roberts-Austen.

The lines are compared with those published previously by Rowland (*Ast. Phys. Journ.* vol. vii. p. 273, 1898) and Hasselberg (*Svenska-Vetenskaps. Akad. Handl.* vol. xxxii. No. 2, 1899). The three records contain many lines in common, but there are also many differences between any two of them. The lines special to any one list have been analysed with the object of either properly establishing their claim to be accepted as true vanadium lines, or possibly tracing them to their true origin. Lines in the Kensington spectra which are due to impurities have been eliminated, as far as possible, by comparing the vanadium spectrum directly with those of forty-three other elements. They are twenty-nine in number, and are traces of the strongest lines only of Fe, Mn, Cr, Co, Ca, Al, Sr and Ag.

Forty-four lines occur in Rowland's list only; thirteen of these have been traced with certainty to impurities of Ca, Mn, Al, Pb or Sr. No origin other than vanadium has been found for the remainder. A list of lines is given which Rowland has previously identified with solar lines, but which, for some reason or other, are missing from his latest list of vanadium lines.

There are 194 lines which occur in the Kensington list only. No other origin has been found for them from a comparison of the vanadium spectrum with those of the forty-three metals which have been photographed on the same scale. As they appear both in the spectrum of the chloride and oxide they are probably genuine vanadium lines.

"The Growth of Magnetism in Iron under Alternating Magnetic Force." By Ernest Wilson. Communicated by Prof. J. M. Thomson, F.R.S.

The subject of the shielding effects of induced currents due to changes of magnetic induction in plates of iron has been dealt with theoretically by Profs. J. J. Thomson (*Electrician*, vol. xxviii. p. 599) and J. A. Ewing (*Electrician*, vol. xxviii. p. 631). The same subject has been attacked by experiment in the case of iron cylinders (*Phil. Trans.* R.S. A vol. clxxxvi., 1895, pp. 93–121, and *Journal* Inst. Elec. Engineers, vol. xxiv. p. 195), and the object of the present paper was to carry out further experiments with alternating magnetic force.

The magnet consists of a solid iron cylinder 12 inches in diameter and 18 inches long, around which the magnetising coil is wound. The magnet circuit is completed by means of a ring concentric with the cylinder and a circular slab of iron at each end.

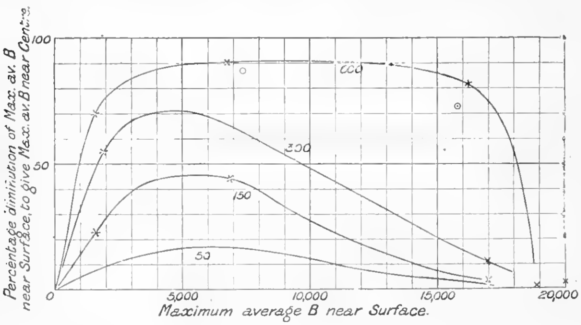


FIG. 1.

In order that changes of magnetism may occur at the centre of the cylinder it was necessary to employ alternating currents of long periodic time. Such times vary from 2·5 to 10 minutes in the experiments. It would be difficult to obtain such currents by means of electro-magnetic apparatus. A liquid reverser consisting of copper plates in dilute $CuSO_4$ solution was employed and gave satisfactory results.

For the purpose of observing the changes of magnetic induction at different points of the cylinder a series of holes were drilled in a plane perpendicular to the axis and half way along its length. Insulated copper wires were then threaded through these holes in such manner that each circuit enclosed an element of the cross-sectional area of the cylinder. Four such elements were enclosed between the centre and the circumference, and a fifth coil was wound completely round the cylinder, as it was required to take account of the average change of induction over the whole area. In the circuit of each of these five coils was placed a dead-beat galvanometer, the deflection of which enabled the E.M.F. to be observed. The epoch for the simultaneous observations of E.M.F. as well as the current in the magnetising coil was determined by the operator at the reverser counting seconds aloud. The E.M.F. curves were ultimately plotted in terms of time and integrated.

Before dealing with the experiments it may be stated that the results obtained are applicable to cylinders of other diameter than 12 inches. Similar electric and magnetic events will happen in cylinders of different diameters, but at times varying inversely as the square of their linear dimensions. Thus a periodic time of 10 minutes with the 12-inch cylinder corresponds to a frequency of 150 periods per second with a wire 1 mm. diameter.

Two variables have been dealt with, namely the frequency of the magnetising force H, due to the current turns in the copper coils of the magnet, and its amplitude. The figure gives one set of results obtained at 15° C. Each curve refers to a definite periodic time, and the number near it gives the frequency for a wire 1 mm. in diameter. The point of interest is that for a given frequency when the limits of the induction density, B, at the surface, are small, that is, the average permeability is small, the limits of B at the centre of the cylinder do not differ greatly from those at the surface. With larger limits of B at the surface, corresponding to a large average permeability, the limits of B at the centre are very much smaller than at the surface. Finally, when the limits of B at the surface are great, corresponding to a small average permeability, the limits of B at the centre are again more nearly equal to those at the surface.

Referring to the average induction over the whole core, that is, taking account of phase displacement as well as variation in amplitude, it may be stated that as the limits of B at the surface increase from zero, the maximum average B over the whole area grows less than B at the surface and then more nearly approximates to it. The curves are similar to those in Fig. 1, but the percentage diminution for a given frequency and a given value of B at the surface is not so great.

The magnet was heated to 53° C. and the effect was to tend to equalise the limits of B over the whole core. In the figure the points ⊙ were obtained when the magnet was at this temperature. The same maximum average B over the whole core is obtained with slightly less amplitude of magnetising force. On account of a greater phase displacement of the change of induction as the centre is approached, the maximum average B over the whole section is not greatly altered for a given maximum value of B at the surface.

Chemical Society, April 18.—Prof. Emerson Reynolds, president, in the chair.—The following papers were read:—Action of alkyl haloids on aldoximes and ketoximes. Part 2. Alkylated oximes and isoximes and the constitution of aliphatic oximes, by W. R. Dunstan and E. Goulding.—The supposed existence of two isomeric triethyloxamines, by W. R. Dunstan and E. Goulding.—Nitrocamphene, aminocamphene and hydroxycamphene, by M. O. Forster. On treating 1:1-bromonitrocamphane with silver nitrate, 1-nitrocamphene,

$$C_8H_{14}<\begin{matrix}CH\\ \|\\ C.NO_2\end{matrix},$$

is produced, and on reduction gives the corresponding 1-aminocamphene, $C_8H_{14}<\begin{matrix}CH\\ \\ C.NH_2\end{matrix}$. On heating the sulphate of this base with potassium nitrite it is converted into 1-hydroxycamphene, $C_8H_{14}<\begin{matrix}CH\\ \|\\ C.OH\end{matrix}$. This substance is of importance as being the enolic isomeride of ordinary camphor, into which it is converted by warm mineral acids.—A contribution to the chemistry of the triazoles, by G. Young and W. H. Oates. The authors discuss the possibility of isomerism in the triazole series as compared with the pyrazoles; they have prepared a number of substituted triazoles from the corresponding semicarbazones.—Researches on moorland waters. Part 2. On the origin of the combined chlorine, by W. Ackroyd. The author concludes that the common salt in the water of the Widdop reservoir in Yorkshire is derived from the winter rainfall.—Robinin, violaquercitrin and osyritrin, by A. G. Perkin. The composition $C_{33}H_{38}O_{20},8H_2O$ is now assigned to the glucoside robinin, which on hydrolysis yields a colouring matter, $C_{15}H_{10}O_6$, identical with campherol. Osyritrin has the composition

$$2C_{27}H_{28}O_{16}, H_2O,$$

and is identical with violaquercitrin.—Preparation of orthodimethoxybenzoin, and a new method of preparing salicylaldehyde methyl ether, by J. C. Irvine. An excellent yield of salicylaldehyde methyl ether is obtained by treating a mixture of salicylaldehyde and methyl iodide with dry silver oxide; it is converted into orthodimethoxybenzoin by potassium cyanate, and this is converted quantitatively into its methyl ether by methyl iodide and silver oxide.—Action of hydroxylamine on the anhydrides of bromonitrocamphane, by M. O. Forster.—On the estimation of cocaine and on diiodococaine hydriodide, by W. Garsed and J. N. Collie. On adding excess of decinormal iodine solution to a dilute solution of a cocaine salt, diiodococaine hydriodide, $C_{17}H_{21}NO_4,HI,I_2$, is precipitated and the excess of iodine may be determined by titration with thiosulphate solution.—Note on acetonylacetone, by T. Gray. The molecular refraction of acetonylacetone agrees with the value required for the ketonic formula.—Condensation of acetonylacetone with hydrazine hydrate, by T. Gray.—Preparation of synthetical glucosides, by H. Ryan and W. S. Mills. Acetochlorogalactose reacts with α-naphthol and potash yielding α-naphthylgalactoside, $C_6H_{11}O_5.O.C_{10}H_7$. Metacresylglucoside is similarly prepared from acetochloroglucose and metacresol.—The influence of cane sugar on the conductivities of solutions of potassium chloride, hydrogen chloride and potassium hydroxide; with evidence of salt formation in the last case, by C. J. Martin and O. Masson.—The aluminium-mercury couple. Part 3. Chlorination of aromatic hydrocarbons in presence of the couple. The constitution of the dichlorotoluenes, by J. B. Cohen and H. D. Dakin.—A modification of Gutzeit's test for arsenic, by E. Dowzard.—On the chemistry of *Nerium odorum*, by R. C. L. Bose. In addition to neriodorein and neriodorin, already known to exist in the plant, the author has extracted a new resin-like substance from the sweet-scented oleander, *Nerium odorum*; this has the composition $C_{21}H_{49}O_6$, and is named karabin.—Change and interaction in organic compounds, by A. Lapworth.—The mechanism of the Claisen reaction, by A. Lapworth.—A new series of di-mercuri-ammonium salts, Part 1, by P. C. Rây. Ammonia acts on mercuric nitrite giving a di-mercuri-ammonium nitrite of the composition

$$2NHg_2NO_2, H_2O.$$

This yields salts of the types $NHg_2Cl,4HCl$ and $2NHg_2Cl,H_2O$, with the halogen acids.

Royal Microscopical Society, April 17.—Mr. Wm. Carruthers, F.R.S., president, in the chair.—Mr. Enock gave a demonstration on the metamorphoses of one of the dragon flies, *Æschna cyanea*. In his endeavours to obtain a complete set of photographs from life which would show every stage in the metamorphoses of the nymph of the dragon fly he had taken over 1000 photographs before he was successful; those he was about to show were taken from the same individual and recorded every stage of the process, which occupied a period of six hours only. Considerable patience and constant watching were required, as after the first indication of change was noticed the dragon fly might emerge at any time in the following three days, and when the process of emergence began it went on rapidly, so rapidly, in fact, that three photographs were taken within the space of six seconds. Mr. Enock then showed on the screen photographs of a nymph to illustrate the remarkable movements of the mask by which the insect was enabled to capture its prey. These were followed by a series of about thirty slides, illustrating every stage of the metamorphosis from the nymph to the perfect insect.—Mr. Nelson exhibited a slide of podura scales under polarised light.

Royal Meteorological Society, April 17.—Mr. W. H. Dines, president, in the chair.—Mr. W. Marriott read a paper on the special characteristics of the weather of March 1901. From March 1 to the 12th or 13th the temperature was slightly above the average, the prevailing winds being from the south-west and often strong in force. About the 13th a change set in, when north-easterly winds became predominant and low temperatures prevailed. This continued with increasing intensity until the 29th, the last two days of the month being nearly of average temperature. The most remarkable period of the month was the five days from the 25th to 29th, when the temperature was more than 10° below the average all over the country. The north-easterly winds were strong in force and particularly keen and dry. At the Greenwich Observatory the relative humidity was only 52 per cent. on the 26th and 54 per cent on the 27th. The only other instance during the past 54 years of as low a relative humidity in the month of March was on March 1, 1886. In consequence of this keen and cold weather, vegetation was at a standstill. Snow showers were frequent but not very heavy, except on the 20th in the south-west of England, when on Dartmoor nearly as much snow fell as in the great blizzard of March 1891; and on the 29th, when a very heavy fall of snow and rain occurred in the north-west of England and Wales. Although the death-rate was below the average, there was a considerable increase in the deaths due to diseases of the respiratory organs.—A paper by Mr. R. Strachan, on vapour tension in relation to wind, was also read.

Anthropological Institute, April 23.—Prof. A. C. Haddon, F.R.S., in the chair.—Specimens of Neolithic implements from the Wilts border of Berkshire were exhibited by Mr. L. J. Shirley.—Mr. Franklin White exhibited stone implements, pottery and silver ornaments from Central Rhodesia; he then read a paper on the ruins of Dhlo-Dhlo, or Mambo, illustrated by lantern slides, photographs and plans. The author gave a detailed description of the nature, dimensions, ornamentation and state of preservation of the ruins, and showed that the theories of the late Mr. Theodore Bent with regard to the Zimbabye ruins would not apply to the ruins of Dhlo-Dhlo, the orientation and other details depending mainly on the character of the ground.—Papers on the Baganda, by Rev. J. Roscoe, and on folktales of the New Hebrides, by Mr. S. H. Ray, were taken as read.

MANCHESTER.

Literary and Philosophical Society, April 23.—Prof. Horace Lamb, F.R.S., president, in the chair.—Dr. Elie Metchnikoff, Paris, was elected an honorary member of the society. Mr. Charles Bailey was elected president of the Society for the session 1901–2.—Prof. S. J. Hickson communicated two papers by Miss E. M. Pratt, upon a collection of Polychaeta from the Falkland Islands, and some notes on the bipolar theory of the distribution of marine organisms. In the first paper Miss Pratt described a small collection of Polychaeta collected in shallow water off the shores of the Falkland Islands. There are no new species, but considerable interest attaches to certain forms which are new to the southern hemisphere, amongst them being *Arenicola claparedii*, now recorded for the first time outside the northern temperate region. The second paper contained a review of the facts of zoology bearing upon the theory that the marine organisms found around the two poles of the earth have been derived from a common or universal fauna, which existed in the past history of the world, at a time when the seas were of a more uniform temperature. It was shown that the evidence in favour of the theory is increasing rapidly, and our knowledge of the details of anatomy of the north and south representative species reveals a closer relationship between them than might have been anticipated.

PARIS.

Academy of Sciences, April 29.—M. Fouqué in the chair.—On the mechanical compensation of the rotation of the optical field furnished by the siderostat and heliostat, by M. A. Cornu. The theoretical solutions of this problem given by Turner and by Lippmann have been anticipated practically by M. P. Gautier, who has devised a simple mechanism for moving the photographic plate with an angular compensating movement sufficiently precise to obtain a good negative with a short exposure (see p. 42).—On the use of oxygen in ascents at great heights, by M. L. Cailletet. A description of an apparatus by means of which liquid oxygen can be used by aëronauts. Its great practical service was demonstrated in a balloon ascent of 5500 metres.—On the stability of a system having a movement of rotation, by M. P. Duhem.—M. Zeiller was elected a member in the Section of Botany in the place of the late M. A. Chatin.—On a generalisation of a definite integral, by M. H. Lebesgue.—On the analytical integrals of differential equations of the first order in the neighbourhood of initial singular conditions, by M. Henri Dulac.—On the equations of certain groups, by M. de Seguier.—On the laws of Belgrand and the formulæ for the delivery of a water-course, by M. Edmond Maillet.—The isochores of ether from 1·0 to 1·85 c.c., by M. Edouard Mack. The experiments confirm the law of Amagat that at constant volume the pressure is a linear function of the temperature.—On the measurement of the period of electric oscillations by the rotating mirror, by M. L. Décombe. A discussion of the precision to be obtained by means of the rotating mirror method and a criticism of results previously published on the same subject by M. Tissot.—On the band spectrum of nitrogen in the oscillating spark, by M. G. A. Hemsalech. It is shown that the band spectrum obtained with the oscillating spark with certain metals is identical with the band spectrum of nitrogen at the negative pole.—The rapid measurement of surface tensions, by MM. Ph. A. Guye and L. Perrot. A study of the conditions under which the method of falling drops gives accurate results for the surface tension of liquids.—On the variation of composition of mineral waters and of spring waters as brought out with the aid of the electric conductivity, by M. P. Th. Muller. The composition of a water having been once determined chemically any variation of its composition from time to time can be most easily detected by determining its electrical conductivity.—On myrcenol and its composition, by M. Ph. Barbier. By studying the oxidation products of this substance it would appear to have the same constitution as that attributed to licareol by Tiemann, but as the physical and chemical properties of myrcenol are altogether distinct from those of licareol it is necessary to reconsider the formula attributed to the latter substance.—On ethyl nitroacetate, by M. A. Wahl. Since the substance obtained by the action of ammonia upon ethyl nitro-dimethylacrylate gave an ethyl nitroacetate which was not identical with the specimen obtained by M. de Forcrand, an attempt was made to prepare this compound by an independent method. The decomposition of ethyl nitromalonate by boiling with potash was finally found to give the compound sought for, which agreed in its properties with the ester previously prepared by the author, but differs from the nitroacetate of de Forcrand.—The preparation of the isomeric ortho-, meta- and para-nitrobenzoylcyanacetic esters and of orthonitrobenzoyl chloride, by M. Mavrojannis.—A new reaction of saccharin, by M. Alex. Leys.—On the migration of nitrogenous and ternary matters in annual plants, by M. G. André.—On the *Voandzou*, by M. Balland. An analysis of the seeds of this plant showed that the proportions of fat, nitrogenous material, starch and ash are exactly those required for human food. It is the first example of a natural product presenting the chemical characteristics of a perfect food.—Contribution to the microchemical examination of alkaloids, by M. M. E. Pozzi-Escot.—On the phenomena of histolysis and histogenesis accompanying the development of the endoparasitic Trematods of terrestrial mollusca, by MM. Vaney and A. Conte.—On the evolution of the blastodermic leaflets in the Nematods, by M. A. Conte.—On a new subfamily of marine Hemiptera, the *Hermatobatinae*, by MM. H. Coutière and J. Martin.—Researches on the physical constants which influence the electrical stimulation of the nerve, by M. Georges Weiss.—The direct measurement of the wave-length in a nerve following short electrical stimulations, by M. Aug. Charpentier.—Some remarks on the otoliths of the frog, by M. Marage.—The influence of the sterilisation of the medium, the air respired and the food absorbed upon the animal organism, by MM. Charrin and Guillemonat. The comparative experiments upon guinea-pigs would tend to show that the absence of bacteria in the air and food is distinctly prejudicial to the animal, which loses its vitality and resisting power to disease.

DIARY OF SOCIETIES.

THURSDAY, MAY 9.

ROYAL SOCIETY, at 4.30.—Discussion of Special Report.

MATHEMATICAL SOCIETY, at 5.30.—(1) A Case of Algebraic Partitionment; (2) On the Series whose Terms are the Cubes and Higher Powers of the Binomial Coefficients: Major MacMahon, R.A., F.R.S.—A Property of Recurring Series: G. B. Mathews, F.R.S.—The Product of Two Spherical Surface Harmonic Functions: J. B. Dale

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Storage Batteries in Electric Power Stations, controlled by Reversible Boosters: J. S. Highfield.

IRON AND STEEL INSTITUTE, at 10.30.—Annual Meeting.

FRIDAY, MAY 10.

ROYAL INSTITUTION, at 9.—The Response of Inorganic Matter to Mechanical and Electrical Stimulus: Prof. J. C. Bose.

PHYSICAL SOCIETY, at 5.—Applications of Elastic Solids to Metrology: Dr. C. Chree, F.R.S.—The Thermal Properties of Isopentane compared with those of Normal Pentane: Prof. S. Young, F.R.S., and J. Rose-Innes.

SOCIETY OF ARTS, at 8.—Polyphase Electric Working: Alfred C. Eborall.

MALACOLOGICAL SOCIETY, at 8.—Description of a New Species of Voluta from Natal, with a List of the Known Forms of Volutidæ from South Africa: E. A. Smith.—Description of a New Species of Voluta, *Cymbiola mangeri*: H. B. Preston.—On Three New Operculates (Cyclotus) from Columbia: S. I. Da Costa.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Results of Double Star Measures made at Windsor, New South Wales, in the Years 1899 and 1900: John Tebbutt.—The Visual Spectrum of Nova Persei: Rev. A. L. Cortie.—The Spectrum of Nova Persei, Note 4: Rev. W. Sidgreaves.—*Probable Papers*: Additional Note on the Position of Nova Persei, and a Comparison of Photographic Magnitudes of Neighbouring Stars with those of Father Hagen's Chart and Catalogue: F. A. Bellamy.—The Cambridge Machine for Measuring Celestial Photographs: A. R. Hinks.—Further Observations of the New Star in Perseus: Radcliffe Observatory, Oxford.

SATURDAY, MAY 11.

ROYAL INSTITUTION, at 3.—The Rise of Civilisation in Egypt: Prof. W. M. Flinders Petrie.

MONDAY, MAY 13.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Survey in Baffinland: Dr. Robert Bell, F.R.S.—Explorations in the Great Bear Lake Region: J. Mackintosh Bell.

SOCIETY OF ARTS, at 8.—Alloys: Sir W. C. Roberts-Austen, K.C.B., F.R.S.

TUESDAY, MAY 14.

ROYAL INSTITUTION, at 3.—Cellular Physiology: Dr. A. Macfadyen.

WEDNESDAY, MAY 15.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—The Periodicity of Cyclonic Winds: Rupert T. Smith.—An Account of the Bequest by the late G. J. Symons, F.R.S., to the Royal Meteorological Society: William Marriott.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Exhibition of Aquatic Life.

SOCIETY OF ARTS, at 8.—Syntonic Wireless Telegraphy: Guglielmo Marconi.

THURSDAY, MAY 16.

CHEMICAL SOCIETY, at 8.—The Nutrition of Yeast, Part III.: Dr. A. L. Stern.—Derivatives of Methylfurfural: H. J. H. Fenton and Miss Mildred Gostling.—The Preparation and Optical Inversion of Optically Active Nitrogen Compounds. dextro- and Lævo-α-benzylphenyl-allyl-methylammonium Salts: W. J. Pope and A. W. Harvey.

FRIDAY, MAY 17.

ROYAL INSTITUTION, at 9.—Turkish Kurdistan: Earl Percy.

SOCIETY OF ARTS, at 8.—Polyphase Electric Working: A. C. Eborall.

SATURDAY, MAY 18.

ROYAL INSTITUTION, at 3.—Rise of Civilisation in Egypt: Prof. W. M. Flinders Petrie.

CONTENTS.

THURSDAY, MAY 16, 1901.

THE SIGNIFICANCE AND SCOPE OF NATURAL SELECTION.

Ueber Bedeutung und Tragweite des Darwin'schen Selectionsprincips. Von L. Plate, Privatdozent an der Universität Berlin. Pp. 1–153. (Leipzig: W. Engelmann, 1900.)

THE great merit of this interesting and thorough piece of work is its explicit recognition of the principle of selection as an indispensable element in organic evolution. We are in some degree prepared for the author's attitude on this question by the last sentence of his preface, in which he asserts that the principle of selection affords at the present time the only scientific explanation of the harmony existing between the endowments of an organism, whether structural or functional, and its surrounding conditions. From this statement it might be supposed that the author not only holds selection to be an essential agent in organic evolution, but that he is also prepared to dispense with the Lamarckian factors, which have certainly been appealed to as furnishing an alternative or concurrent explanation of the same harmonious relations between organism and environment. Such, however, as will be seen later, is not the case.

Nothing could be better than the impartial and judicial spirit of the opening pages, in which the author moves methodically on from point to point, clearing the ground of misconceptions, and disposing conclusively of a long series of well-known but futile objections to the theory of natural selection. Presently he takes in hand the case of the superior oblique muscle of the orbit, and shows admirably how the difficulties disappear on reference to the facts of comparative anatomy. But at this point he lets fall an *obiter dictum* which, in view of his opening declaration, is somewhat startling. The development of a muscle-tendon, he thinks, may be explained as the consequence of a pull exercised in a certain direction through many generations. We are thus confronted with a re-entry of Lamarckism; and, reading on, we find abundant proof that Plate, so far from really holding that the phenomena of adaptation are only to be explained by selection, thinks it necessary to supplement that principle by the hereditary transmission of acquired characters. Thus the parachute-like membranes of the flying squirrels, *Galeopithecus*, flying lizards, and the like, are considered by him to have originated from a stimulus exercised by the outstretched limbs upon the skin of the sides of the body, the effects of which accumulated for many generations (p. 31). The ischial callosities of monkeys were produced by the sitting posture (p. 36). The loss of hair and development of blubber in the whales may be due to the direct action of water on the skin and subcutaneous connective tissue (pp. 111, 142). In short, the author leaves us no room to doubt that he believes in use-inheritance, and in the possibility of the transmission of characters however acquired.

On turning to the grounds for his belief, we find them stated as follows (p. 55):—(1) All or almost all of the somatic cells may be supposed to contain germ-plasm; this is made probable by the phenomena of regeneration. Moreover, the whole of the germ-plasm, whether of the somatic or genital cells, may be conceived of as forming a network whose nodes are situated in the nuclei of the different cells. A peripherally-started impulse would be propagated along such a network in all directions, and in this way a somatogenic character might become transmissible by descent. (2) Use-inheritance forms the simplest explanation of co-adaptation. (3) Many phenomena can only be understood by reference to orthogenesis, *i.e.*, the cumulative effect of a stimulus acting through many generations. (4) The gradual dwindling of rudimentary (vestigial) organs must be accounted for by inheritance of the effects of disuse.

Of these, the first is mainly speculative; moreover, were the initial assumptions granted, it would still be far from clearing up the actual mode of the supposed transmission. Two of the others have no doubt been felt as difficulties by some of the upholders of natural selection, and have already been pressed home by Herbert Spencer; but there are other ways of accounting for these and similar phenomena which seem more satisfactory than the recourse to Lamarckians' explanations. Plate very candidly admits that there is at present no direct proof of the transmission of acquired characters, and it is unfortunate that he burdens his argument for selection with the unnecessary weight of an unproved and improbable hypothesis. His real reason for declining to rank himself with the anti-Lamarckian is probably the difficulty that he finds, in common with many others, in assigning selection-value to the early stages of variation. But, as Wallace and others have shown, when the actual variations come to be fairly examined, it appears that ample material for selection exists from the outset. It is worthy of note that Plate himself, in discussing Cunningham's strictures on Weldon's experiments with crabs, admits that the latter has virtually shown the selection-value of slight differences of structure.

A large portion of the treatise is devoted to the subject of sexual selection. An excellent classification of secondary sexual characters is given, and the whole question is treated on broad and generally rational lines. It is to be regretted, however, that the author, in emphasising the slenderness of the evidence for female choice that at present exists, has failed to do justice to the statements of some opponents. An instance of this occurs in the case of an observation of Poulton's, whom Plate represents as having watched the female of such a moth as *Saturnia carpini* resting motionless amidst a crowd of fluttering males, all of them most eager to pair, but unable to do so until the female, in some way imperceptible to the observer, made her choice. Poulton's interpretation of the facts is somewhat curtly rejected, and the subject is dismissed. A reference, however, to the original account will show that the argument is inaccurately given. The moth specified is not *Saturnia carpini* or one of its allies, but the widely removed *Charaeas graminis*. On the other hand, Poulton expressly says that the female of *Saturnia carpini* "in its present condition is certainly passive, and probably always accepts the attention of the first male to arrive." The slip would matter little were it not that it has the effect of obscuring Poulton's argument, which rests on the observed facts that the females of some moths (as *Saturnia carpini* and *Orgyia antiqua*) accept the first male that arrives, while those of others (as *Charaeas graminis*) allow a period of competitive courtship; and, further, that as a rule moths with bright colours belong—or at a former period did belong—to the latter group rather than to the former.

Plate's own view as to female choice is that it is exercised only as between pairing and not pairing. There is, he thinks, plenty of evidence as to success or failure of incitements employed by the male, but little or none of choice by the female between individual suitors. The distinction seems rather delicate. A would-be pairer may fail from want of sufficient power to charm the female; but rejection implies choice, and if competitive incitement *does* take place, as Plate seems to allow, whether simultaneously or successively, how does this differ from sexual selection in Darwin's sense?

On the subject of "sports," the author is no doubt right in contending that they have little or no bearing on the question of species-formation. But before unreservedly asserting that they must tend to be swamped by intercrossing with the parent species, he would have done well to examine the evidence brought forward by Standfuss and others in support of the position that the crossing of an aberration with the parent form may often result, not in the production of intermediate types, but in the sharp cleavage of the offspring into two groups, each resembling one of the parents and not the other. If these observations and experiments are to be relied on, they imply the theoretical possibility of a sport, supposing it to be selected, eventually displacing the parent form; and, indeed, there is little doubt that under domestication something very much like this has actually occurred.

The treatment of adaptation is in many respects excellent. Kallima, the well-known Indian genus of leaf-like butterflies, is once more brought to the front and used as a conclusive instance of selection, furnishing also a good *reductio ad absurdum* of the "photographic" theory. But the author introduces a needless confusion by his method of handling the subject of "direct" and "indirect" adaptation. The former, he says, is repudiated by the "School of so-called Neo-Darwinians," of whom he specifies Weismann, Wallace and Spengel. It is certainly repudiated by them in the sense that they see no evidence for the "transmission of modifications due to individual plasticity," to use Lloyd Morgan's expression. But a distinction much more in accordance with the facts is that between "variable" and "invariable" adaptations. In the former are included such cases of individual assimilation in colour to surrounding conditions as have been principally made known, in the instance of caterpillars and chrysalises, by the labours of a "Neo-Darwinian." These adaptations are apparently "direct" in the sense that they mark a reaction of the individual to its own environment, but not in the sense that they are in any way actually produced by that environment. In common with all other cases of adaptation, whether variable or invariable, they are ultimately the result of a process of selection. The sensitive species is selected, not because it is green or because it is brown, but because in response to the appropriate conditions it is capable of becoming either one or the other. Plate's inclusion of Haeckel, Lloyd Morgan, Osborn and Henslow in the same category of believers in "direct adaptation," together with his criticism of Baldwin on an earlier page, serves to show that he has imperfectly grasped the point at issue. What we hold to be the true doctrine has been excellently expressed by Spengel in a passage quoted by Plate with disapproval (p. 141).

Though we have felt bound to express dissent on many points, we must not be taken as undervaluing Plate's labours. On the contrary, we have formed a high opinion of his knowledge, industry and argumentative power. As a champion of the indispensability of natural selection he has done excellent service, and it is only to be regretted that in adopting this illuminating principle he has failed to set himself free from the bonds of what seems to us a fanciful and unnecessary adjunct. F. A. D.

A TEXT-BOOK OF ELECTRICITY.

Deschanel's Natural Philosophy. III. *Electricity.* By J. D. Everett. Pp. xii + 358. (London: Blackie and Son, Ltd., 1901.)

PROF. EVERETT'S "Deschanel" is too well known to need commendation, and the new edition which is now before us has the many merits of its predecessors. The account it gives of fundamental electrical phenomena is admirable, the descriptions of apparatus are clear and good, though at times slightly too concise, the printing is well arranged and accurate, and the illustrations are excellent. In places, it is true, we recognise old friends which have done duty somewhat too often.

At the same time, the task just now of writing a really satisfactory text-book of electricity is a most difficult one, and Prof. Everett's success is not complete.

"The work," he says in his preface, "is in the main new. Electrical theory has been revolutionised during the past few years; and great need exists for a text-book which shall present the subject in its present shape as a clear and connected whole without demanding on the part of the reader an exceptional amount of mathematical knowledge. This is the want which I have endeavoured to supply."

"The work is *in the main* new." Prof. Everett has hampered himself in his attempt to give a modern theory of electricity by retaining even that part of the old which he has kept; the result is somewhat of a patchwork. Thus, Maxwell's conceptions with regard to electric action in dielectrics are introduced as "a new chapter in electrostatics." What was wanted was not an additional chapter in an old book, but an elementary account of the fundamental phenomena of electrostatics, given in the language of Maxwell's theory.

The book commences with electrostatics, and of necessity the language used at first is that of the theory of action at a distance. A charged body attracts light bodies and repels other bodies similarly charged; the action of a gold leaf electroscope depends on the repulsion between the like charges of the leaves; the electrophorus is described as a means of obtaining electricity in small quantities, but no explanation is given in §30 of its action.

The idea of electric potential is introduced in chapter vi., the first of the chapters in large type. These, it is said, "will be found to contain a connected account of everything essential to a first course of modern electrical theory."

But in chapter vi. the definition of potential is a mathematical one. The distinction between scalar and vector quantities is drawn, and it is pointed out that in many cases the line integral of a vector between two points is independent of the path, and that in this case the vector is said to have a potential, the value of the line integral being the difference of the potentials at the two points which are taken as the extremities of the path.

A number of mathematical propositions connected with the theory of potential are then proved or illustrated in a very interesting way; but the application of the theory to the fundamental facts discussed in the earlier chapters is hardly attempted.

The beginner might be given some idea of the nature of potential without being asked to grasp the meaning of a line integral. Faraday's and Maxwell's notions as to the tension along the lines of force and the pressure perpendicular to them which occurs in a dielectric medium may be used, without the introduction of symbols, to explain the simple attractions and repulsions described in the earlier chapters; the link between the ancient observations and the modern theory is wanting, and the loss to the reader is very marked.

The same want is illustrated in the two following chapters. The quantity K, the specific inductive capacity of a medium, is defined in the usual way in §70, and a footnote tells us "it is identical with the permittivity or dielectric co-efficient K." This statement is repeated in the next chapter, on electric action in dielectrics, but the author does not explicitly establish the connection; a few words at the end of §86 would do it, the words, however, are wanting.

Or again, K is defined as the ratio of the polarisation, or the intensity of the electric displacement, to the force. Now the force has a perfectly definite meaning, and the inductance K can be defined in unambiguous terms; why then make it depend on "a peculiar distortion called electrical displacement" which is "roughly represented by supposing every tube of force to be divided into cells by elastic membranes firmly attached to the tube, these cells being completely filled with incompressible liquid. The distortion does not displace the sides of the tube, but it displaces the liquid a little way along the tube, in the direction of the force F, further displacement being prevented by the elastic resistance of the membranes."

The inductance of a dielectric is too important a physical quantity to be defined in terms of something which can only be explained by an incomplete analogy; it is surely better to say that the force between two given charges is found to depend on the medium in which they are placed, so that the complete law of force is $F = ee^1/Kr^2$, where K is a constant for a given medium, and is known as the permittivity or inductance of the medium. Then the statements in §80 as to the modification of fundamental formulæ follow naturally; as it is, they seem to the reader to depend on the analogy between the flow of a liquid and electric displacement, and not to rest on an experimental basis.

The earlier chapters on magnetism are clear and good, §148, giving the reason why a bar of soft iron sets parallel to the lines of force, may be specially commended. Chapter xiii. gives a useful development of magnetic theory; the proof of the relation, however, between B and H, §158, might be given in fuller detail, and a reference to §83 as well as to §90 would not be misplaced.

The rest of the book is taken up with the theory of electric currents and electro-magnetism, and can, on the whole, be warmly commended. The description of instruments, ammeters, voltmeters and the like is brought up to date. At times, possibly, almost too much is attempted for the space available, *e.g.*, in the very condensed account of the ballistic galvanometer in §200. Again, some preliminary account of a voltaic cell is needed before §213, which begins "In a circuit consisting of a battery of four similar cells."

In places the book would be improved by a more distinct reference to the fundamental experiments on which the various laws are based. Thus in chapter xix., after a reference to a statement as to the force exerted on a wire carrying a current in a magnetic field, we pass on to "two fundamental formulæ." These formulæ give the electrical and mechanical forces on a conductor carrying a current when in a magnetic field, and various important deductions are drawn from them in an admirable manner in the following paragraphs. But we miss any clear indication of the method by which these two fundamental formulæ are deduced from experimental results.

The chapter on dynamos is specially good; there is sufficient detail to enable the student to grasp the principles which underlie the action of the various forms, while at the same time the book is not overburdened with accounts of small differences of construction which, though they are of great importance to the student of dynamo design, have no place in a general text-book.

Enough, perhaps, has been said to show the value of the book. Prof. Everett has rendered a real service to his readers by his new edition; the book is one which is sure to become popular and to be valued alike by teacher and by student.

AN ESSAY IN CRITICAL BIBLIOGRAPHY.

The Periodic Classification and the Problem of Chemical Evolution. By G. Rudorf. Pp. xvi + 228. (London: Whittaker and Co., 1900.) Price 4*s*. 6*d*.

THE object of this work, as stated by the author in his preface, is one which should command hearty approval. The author aims at presenting a summary of the work done and the speculations advanced in the particular field indicated in the title. The publication of such summaries has long been customary in Germany, and it is to be hoped that the custom may become more common in England. Most text-books published in this country suffer from one or other of two defects. Either they are very elementary in scope and wholly didactic in treatment, or they are diffuse in treatment and of unmanageable size. This work certainly does not fall under either condemnation. It deals with a difficult subject, and is rather suggestive and argumentative than didactic. On the other hand, it is neither unreasonably long nor over-elaborate in treatment. Indeed, it sometimes errs in the other direction.

The first part deals with the history of the periodic law and the experimental evidence for periodic variation of properties with atomic weight, and in many cases information is given in so condensed a form that it must be well-nigh unintelligible to those whom the author has avowedly sought to benefit, students "who may not have either time or opportunity to refer to the original literature." This is particularly the case in the portions which deal with various attempts to formulate numerical relations between the atomic weights.

In the second part of the book the author seeks to establish the theses (1) that "the elements have a fixed, definite structure," (2) that "the elements are complexes of some primary material," and (3) that this primary material is hydrogen. Dealing with the first of these, the author gives a sketch of the evidence to be derived from stereo-chemistry which is so short that it amounts to little more than a series of references, but which is useful so far as it goes. The inference that the elements in any one group of Mendeléeff's table should all have the same shaped atom is somewhat sweeping, but is opportunely supported by the recent work of Messrs. Pope and Peachey on optically active tin compounds.

As to the second, the arguments which have been advanced in support of it are fairly well presented, but the author misses altogether the point that the "meta elements" of Crookes supply an essential link in the chain of reasoning by which it is possible to reconcile the discontinuity implied in the atomic theory and the periodic law with the continuity predicated in the hypothesis of protyle.

In support of the third proposition, that protyle and hydrogen are one, the author adduces several well-known arguments, many of which, particularly those based on stellar spectroscopy, are fairly well stated and of acknowledged cogency. But his answer to the obvious difficulty that the atomic weights are not whole multiples of that of hydrogen is, though not unfamiliar, decidedly unsatisfactory. That the third law of motion may be valid only where molar masses are concerned is, of course, a legitimate suggestion, but it is a suggestion in support of which no fact save the difficulty under discussion can at present be adduced. It is surely as reasonable to regard that difficulty as fatal to the hypothesis that hydrogen is protyle as to find in it a reason for doubting the universal applicability of the third law of motion.

The author, moreover, minimises in an extraordinary way the remarkable evidence which has been accumulated through the study of ions produced in gases by the action of Röntgen rays, Becquerel rays and ultraviolet light. "The portion of this book dealing with chemical evolution was," we are told, "submitted to Sir Norman Lockyer," and some of the notes which he made upon it are prefixed to the volume. In them attention is drawn, more than once, to the importance of this work on gaseous ions in relation to the problem under discussion. The author does, it is true, add to these notes a brief abstract of one of Prof. J. J. Thomson's papers. But the matter is far too important to be thus disposed of in a prefatory note. The fact that the negative ion in gases has a mass which is very small compared with that of an atom of hydrogen is well established, not only by the researches which the author quotes, but by other and later work of Prof. Thomson on the negatively charged particles given off when ultraviolet light falls on a zinc plate, and also by the experiments of MM. Becquerel and Curie on the radiations emitted by radium. The conclusions to be drawn from these researches, while they are in full accord with the view that the elementary atoms of the chemist are themselves complex aggregates of yet smaller particles, require that these particles should be of an order of magnitude so far inferior to that of a hydrogen atom that they cannot fairly be described as "hydrogen" at all.

If, as may be expected, a second edition of the work is called for, it is to be hoped that the author will take the opportunity of incorporating these results, and with them the still later work of Prof. Townsend on the variations of conductivity in rarefied gases, the results of which also emphasise in a remarkable way the extreme smallness of the negative ions.

In conclusion, it must be said that the author has occasionally suffered unduly at the hands of his printer. There are a number of ordinary misprints which might be expected in a work of the kind, but a worse piece of printing than that of the numerical expressions illustrating the summary of Dr. Dulk's paper (on p. 71) it would surely be difficult to find.

A. F. W.

OUR BOOK SHELF.

Der Gesang der Vögel. Von Dr. Valentin Häcker. Pp. 1+102. (Jena: Gustav Fischer, 1900.)

THIS is an exceedingly interesting and useful contribution, and may be regarded as perhaps the most accurate and complete summary of this subject extant.

The author devotes the opening pages of his work to purely anatomical details, illustrated by numerous text-cuts representing voice organs of the passerine type. He introduces, for purposes of comparison, a short description and a figure of the tracheo-bronchial region of the reptile, the tortoise being selected as the most suitable.

The second chapter opens with a reminder that the variety of tone and range of vocal power depends largely on the modification of the upper ends of the bronchial tubes and the lower end of the syrinx. This is supported by a brief survey of the simpler types of syrinx ending in the very perfect voice organ of the Passeres, with its complicated muscular system and fusion of tracheal rings—the tracheo-bronchial syrinx.

That muscular development, however, does not necessarily imply great powers of song is, as he rightly remarks, well shown by the fact that the muscles of the raven and thrush are precisely the same in number and distribution. Furthermore, the muscular system of the raven is the better developed of the two; but there can be no doubt, in spite of this, which is the better songster! Again, though the songs of the true Passeres are extremely varied, yet there is no perceptible variation in the muscular system; indeed, such variation is obviously unnecessary, for the same bird may, and does, repeat the song of numerous other birds as proficiently as the birds to whom the songs rightly belong.

It is interesting to note that Dr. Häcker seems to have shown that sexual distinctions in the syrinx can undoubtedly be demonstrated, that of the female being always more feebly developed. This being the case, one would scarcely have supposed that the female, as in the case of the bullfinch, for instance, would sing as well as the male, but so it is.

Castration acts directly on the syrinx, much as on the horns of deer, for instance; the capon having a syrinx like that of the female. Young males appear to have a more powerful syrinx than adult females.

The chapter dealing with the development of song and other forms of display are full of thoughtful matter. Special mention is given to Rohweder's recent interpretation of the curious bleating or drumming of the snipe. This observer contends that this strange music is caused by the rapid vibration of the horizontally extended and half-closed wings, which drive a strong current of air against the stiffened outer tail feathers, setting them in rapid vibration, and causing the curious tremulous bleating sound. This explanation differs somewhat from that of Meeves and others, and is probably the most nearly correct explanation we have yet had.

We heartily commend the book to the notice of ornithologists. W. P. P.

Physikalisch-chemische Propädeutik. Zweite Hälfte, 1–3 Lieferungen. Von H. Griesbach. (Leipzig: W. Engelmann, 1896–1900.)

THIS book, the first part of which has already been reviewed in NATURE, is chiefly intended for those interested in medical science. In it Prof. Griesbach discourses of everything from the law of gravitation and the conception of potential to the chemical nature of disinfectants and the morphology and physiology of bacteria. There is no particular arrangement in the book; chapter xxiii, on molecular mixtures, occupies 232 pages, whilst chapter xxiv, on the factors of energy, occupies 4. It must not be supposed, however, that the book is on this account uninteresting—far from it; it is excellent reading, and is both wonderfully accurate and wonderfully complete. Indeed, the struggle after completeness seems to be the author's chief failing. In connection with semipermeable membranes, he happens to mention sugar. This at once prompts him to give the means of detecting sugar:—smell of caramel, "French word from Latin *canna mellis*, honey-cane, *i.e.* sugar cane," and reduction of Fehling's solution, which necessitates a short biography of Fehling. Exact instructions for the preparation and use of Fehling's solution are then given. This, of course, involves reference to Rochelle salt, whence "Pierre Seignette, born when and where? physician and apothecary in Rochelle, died at Rochelle, 11 March, 1719." After nearly two large and closely printed pages we get back once more to semipermeable membranes. This is propædeutic with a vengeance.

Despite its faults of method the book is a mine of valuable information, and can be cordially recommended to any medical man with a taste for the physical sciences.

Annals of Politics and Culture (1492–1899). By G. P. Gooch, M.A., with an introductory note by Lord Acton. Pp. 530. (Cambridge: University Press, 1901). Price 7*s*. 6*d*. net.

THE object of this work, as set forth in the preface, may at first sight appear pretentious and impossible of achievement, viz., to present "a concise summary of modern times, embracing the life of mankind in its entire range of thought and action." As soon, however, as the reader has mastered the plan of the book it will be found that the author has carried out his object—originally suggested by Lord Acton—with remarkable skill and completeness. Politics occupy the left and culture the right hand series of pages. At the top corner of each page is the date in conspicuous type, and a further subdivision under the two headings enables the reader to pick out at once the particular subject or country. The political subjects are classified under countries and the culture subjects under various headings, such as art, science, philology, history, philosophy, literature, education, economics, archæology, social, deaths, &c. Of course it is the scientific references that will chiefly appeal to our readers, and so far as we have tested these they appear to be both accurate and complete. The author has evidently been well advised in his choice of scientific events and due proportion as to the relative importance of discoveries in different branches of science which, under a chronological classification, have necessarily to be brought into juxtaposition, has on the whole been carefully observed throughout the long period of more than four centuries covered by the work. A very complete index, composed both of names and subjects, is correlated with the contents of the volume by reference numbers and not pages, ordinary numerals referring to politics and italicised numerals to culture subjects. As a book of reference, workers in the history of science will find Mr. Gooch's volume of great value. R. M.

The Child: His Nature and Nurture. By W. B. Drummond. Pp. 146. (London: J. M. Dent and Co.; no date.) Price, 1*s*. net.

IN the preface of this primer it is stated that the book is intended as an introduction to the study of the physical and mental development of the child, and it is admirably fitted for this purpose. It covers a wide range, but is concise, clear and interesting, and brings within a small compass the result of recent work in the study of children. It is a book which should be in the hands of every one who has to do with children, and besides being a practical help in dealing with the infant and growing child, we think it will stimulate further child-study.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Smithsonian Solar Eclipse Expedition.

THE Smithsonian Institution has sent out a small party to Sumatra, under the immediate charge of Mr. C. G. Abbot, to continue certain of the observations described in NATURE of July 12, 1900, where these, on account of the narrowness of the eclipse track and the brevity of the time, were indeterminate.

The expedition sailed on February 16 in the Government transport *Sheridan*, and the Institution has learned of the arrival of the party at Padang, Sumatra, on the *General Alava*, a United States naval vessel.

The objects principally sought are, such a thorough photographic search in the neighbourhood of the sun, for possible intramercurial planets, as may be apt to set the question of their existence at rest; and also a further and more complete study, by the bolometer, of the heat of the corona.

The observations of May 1900 were three in number:—

(1) One on the radiation from the screen. This was arbitrary and may be called zero.

(2) One on the dark moon, giving on the millimetre scale -18, showing that the bolometer was radiating to the moon.

(3) One on the inner corona, giving -13, showing that the bolometer was radiating to it, though in a less degree than to the moon.

The algebraically increased reading for the coronal radiation then $(-13-(-18) = +5)$ was probably due to this coronal radiation, together with possibly something from the different radiations of the closely neighbouring parts of the sky used in the two observations.

Since the Wadesboro experiments the bolometer has been set on a screen of its own temperature, giving zero; on the bright moon, giving $+55$, and on the night sky near the moon, giving -30.

From my study of the visual photometric observations made at Pike's Peak in 1878, and at other places, it appears that the average visual brightness of the portion of the corona covering the bolometer at Wadesboro was approximately equal to that of the full moon.

I infer, then, that the full moon being of the average brightness of the observed portion of the inner corona, the bolometric effect of its visual radiation may be supposed to be equal to that of the latter; but the observations above recorded show that the total radiations from the moon being $55+30$, or eighty-five bolometric divisions, are seventeen times as great as the radiations from the inner corona, and hence it may be supposed that the corona lacks that large amount of infra-red radiation which is proper to the moon's spectrum.

The moon's spectrum, however, is that of a heated solid body, and all heated solid bodies, and heated gaseous bodies as well, send to the bolometer large amounts of infra-red radiation. So far, then, we might conclude that the inner corona has not the radiations of a hot solid or gaseous body, but, owing to the lack of a contemporary measure of the sky radiation just outside the corona, and of a full knowledge of the influences that the atmospheric radiations would have on our ability to discriminate this, the above conclusions seemed to me only probable, and worth verification at the forthcoming eclipse.

Smithsonian Institution, April 29. S. P. LANGLEY.

The Persistence of the Spectrum of Carbon Monoxide.

THE letter of Dr. Carl v. Wesendonk (p. 29), which gives an account of the spectrum of carbon monoxide appearing in a vacuum tube containing silicon tetrafluoride, affords an instance of the extreme difficulty of obtaining vacuum tubes charged with perfectly pure substances. The case he cites of silicon fluoride being prepared from "pure" sulphuric acid, glass and fluor spar, without any but glass joints to connect the different parts of the apparatus, is one in which neither the perfect freedom of the sulphuric acid, nor of the glass itself, from carbon compounds can be relied upon. In experiments on the absorption spectrum of ozone made by me in 1881, it was found that strong sulphuric acid free from all the usual impurities was not absolutely clear, but by being kept in an atmosphere containing a large proportion of ozone it became perfectly brilliant and absolutely colourless when seen in volumes of half a gallon to two gallons at a time. It appeared from further experiments that the impurities were either carbon or some form of organic matter probably coming from dust or dirt. As to the purity of the glass used for vacuum tubes, it may be remarked that dust and condensed vapour from carbonaceous matter, such as the products of combustion from lamp oil or coal, adheres to its surface with much tenacity. It is probable that the fluor spar contained organic matter, for the reason that this substance is associated with limestone of a bituminous character in England and that it has been asserted that its colour is due to organic substances. By the action of sulphuric acid a gaseous carbon compound might easily be evolved which would contaminate the silicon fluoride even if there were no carbonates present. Next we have to consider the traces of air which may remain in the tube, and must not regard these as being absolutely free from hydrocarbons. M. Armand Gautier has shown that there are combustible gases in the atmosphere, one of which is a hydrocarbon, the other hydrogen, and there is also some carbon monoxide. The difficulty of removing these by ordinary chemical treatment is so great that special operations and reagents were provided for their removal.

In vacuum tubes it is known that carbon monoxide shows its spectrum brilliantly when the pressure is extremely low, and that subsequently it disappears. The very interesting research of Prof. Smithells on "The Spectra of Carbon Compounds," in the April number of the *Phil. Mag.*, illustrates this. Furthermore, it shows distinctly that the same spectrum is obtainable from both carbon monoxide and carbon dioxide (*loc. cit.* pp. 489 and 490). We know, too, from the experiments of Regnault and of Bunsen on the analysis of atmospheric air, that carbon dioxide is absorbed by glass. In view of the facts quoted by Prof. Smithells, the carbon monoxide spectrum is, in his opinion, really due to carbon dioxide, but this latter may easily be decomposed into carbon monoxide and oxygen under the influence of the spark discharge.

The Swan spectrum, attributed variously to a hydrocarbon and to the element carbon by previous investigators, is, according to Smithells, to be attributed to carbon monoxide. It appears also in Dr. v. Wesendonk's letter that when the glass tubes in which the electrodes were fused had become heated, the carbon monoxide spectrum was faintly visible. This would be quite in accordance with the probability that carbon dioxide was evolved from the glass.

A tube containing silicon hydride also showed the carbon monoxide and the Swan spectrum, as well as hydrogen and mercury lines, but no silicon lines were observable. Considering all the facts of the case, it is not conceivable that the spectra in question arise in any way from the decomposition or dissociation of the silicon in the compound, either in the state of vapour as fluoride, of gas as hydride, or in the solid state as glass. W. N. HARTLEY.

April 25.

The Use of "Axis-vectors."

THE effort to popularise the elements of vector algebra is commendable. The power and the direct insight conferred by the use of vector quantities should be sought consistently in the study of physics; and it is true that the introduction of these methods has been needlessly postponed. But it lies in the very nature of such benefits that they are not to be secured except upon tenable grounds and as the result of a continuous argument. If a particular quantity is to be classed with vectors, that cannot be done upon a basis which is reducible to the bare statement: "This magnitude may be represented by a straight line of given direction and length; therefore it is a vector." Witness, for example, moment of inertia, which is not properly a vector, although its magnitude can be associated with a rotation-axis. Vector quantities must be subject to the process of "geometrical addition"; there is a total obtainable as the vector sum of constituent parts. This is equivalent to saying that there is a greatest value Q (resultant) for one direction, and that the law of orthogonal projection applies. Thus the value Q_1 for any other direction must satisfy the equation

$$Q_1 = Q \cos (Q_1, Q).$$

This projective property must be proved somehow in each case.

The conception of a vector is usually established as an elementary matter with the aid of instances like velocity and force. Velocity is so closely connected with linear displacement that the operations of geometrical addition and projection can be almost intuitively recognised as valid for both quantities. The graphical representation of forces, and the application to them of the "parallelogram construction," can be approached from the experimental side, furnishing a timely reminder that this procedure (as regards physical quantity) is ultimately justified by appeal to phenomena. The inclusion of "axis-vectors" (*e.g.* angular velocity and acceleration; moments of force and of momentum) in the class is a second step, of no less importance than the first. The proofs put forward to cover this extension of the thought afford fruitful material to the student of applied logic, through their variations of scope and emphasis. The analysis of some demonstrations now current prompts the remarks which follow.

First, linear vectors, like velocity, force, magnetic field, have what may be termed objective direction. But direction is assignable to axis-vectors by usage only, in the line of a (possible or actual) rotation-axis. Further, the sense in this line is arbitrary, being determined, for example, by the "rule of the right-handed screw." This double convention underlying the graphical representation of axis-vectors must be insisted upon.

Secondly, the theorem known as the "parallelogram of angular velocities" is really intended to prove that the linear velocities of all points in a rigid body satisfy the conditions of rotation in certain cases. The characteristic of rotation is a relation to the axis as regards the direction and the magnitude of all velocities, usually expressed as $v=r\omega$, v being perpendicular to both r and the rotation-axis. The proof of the theorem is only implicitly complete, if we content ourselves with showing that simultaneous angular velocities about intersecting axes produce zero linear velocity on a particular line. And the corollary covering the most important point is often not even mentioned. Similar considerations apply to angular acceleration.

Thirdly, the direct graphical representation of force-moment is connected with areas and not with lines. These areas are in general parallelograms, with adjacent sides representing the force and the distance of its point of application from a chosen point on the rotation-axis. The fundamental case is that in which the parallelogram is perpendicular to the axis, and its area shows the moment for a line through one vertex. For an oblique axis through the same vertex, the moment is obtained by projecting that area upon a plane perpendicular to the new axis. This follows easily from the definition of force-moment.

On adopting a convention governing signs, couple-moment can be represented, for a normal axis, by an algebraic sum of areas. The application here also of the projection-process is an immediate consequence, and it is seen that the values of couple-moment for all parallel axes are equal. The final step in making the transition to the axis-vector is the convention according to which areas are represented by lengths properly laid off on their normals. The process of reasoning for moment of momentum is entirely parallel to that outlined for moment of force. And it can be shown (cf. Heaviside, "Electromagnetic Theory," i. p. 181) to cover the cases of angular velocity and acceleration. For the representation of an area by a length of its normal is the basis of the idea in the vector product of two vectors. The argument of the present instance forms a good elementary introduction to that conception. F. SLATE.

University of California, April 24.

The New Comet.

ALTHOUGH others besides myself have probably noticed the remarkable inconsistencies in the published reports of the new comet, it seems worth while to draw attention to them. Its reported position for April 25, May 2 and May 4 are based on telegrams from the Cape and Peru, and there seems no reason to doubt their correctness. If, however, they are accurate, the comet could not have been seen in England in the morning, as at no time did it rise till after the sun. Yet Mr. Chambers saw it at Eastbourne at 3.5 a.m. on the 2nd, and a correspondent in the *Daily News* says it was fifteen degrees above the southern horizon at 3.30 a.m. on the 7th. E. C. WILLIS.

Southwell Lodge, Ipswich Road, Norwich, May 13.

Blood-Rain.

IN view of the recent letters in NATURE regarding the fall of red rain in Italy, the following extract from Roger of Wendover's Chronicles of the year 1223 may possibly be of interest:—"In the same year it rained blood-coloured earth at Rome for three days, to the great wonder of numbers of people (vol ii. p. 444 of Bohn's edition of Wendover's "Flowers of History.") It is rather curious that so miserably superstitious a *gobemouche* as Wendover should have described the phenomenon so accurately instead of calling it a rain of blood.

Polperro, Cornwall. F. H. PERRY-COSTE.

THE ANTI-VIVISECTION SOCIETY AND LORD LISTER.

THE Anti-Vivisection Society held its annual meeting last week in St. James's Hall. We know these annual meetings; they are accompanied by an annual crop of distortions of scientific work and an annual volley of scurrilous charges against scientific workers and philanthropic administrators. Beforehand, all the perseverance of the accomplished party "whip" is drawn upon to get these meetings together, and afterwards all the ingenuity of the unscrupulous pamphleteer to boom in the Press what has taken place at them. The usual copies of certain daily papers marked in blue pencil under the name of Mr. Stephen Coleridge are sent out broadcast, reporting in detail the sentiments of the audience and the horrors of so-called vivisectors. Were this all it might well be passed over in contemptuous silence, but this year it pleased the meeting to impugn the philanthropic impartiality of one whom all the scientific, and indeed cultured, world delights to honour.

Mr. Coleridge gravely informed his audience, after having discoursed inaccurately on Lord Lister's scientific work, that this man of science was the intimate friend of fifty-eight licensed vivisectors, presumably because he had signed a certificate exempting them from the use of anæsthetics in their scientific experiments. These certificates were signed by Lord Lister in his capacity as president of the Royal Society, and the probability is that personally he was not acquainted with half-a-dozen of the licensees. Mr. Coleridge carefully avoided telling his audience that the vast majority of these "horrid vivisections," in which the use of anæsthetics was dispensed with, were simply inoculations, or, in other words, mere pin-pricks; also that by the Prevention of Cruelty to Animals Act only very few persons of high scientific standing and training can sign these certificates, and that the president of the Royal Society is one.

Mr. Coleridge next turned his attention to scurrilous charges against Lord Lister, in particular, as chairman, and the committee, in general, of the Prince of Wales's Hospital Fund. He impugned the integrity of these gentlemen in that he stated they had given larger grants per bed to those hospitals which either had licensed laboratories attached to their medical schools, or had upon their staffs physicians and surgeons who were actually vivisecting, or had at some past time done so, than to those hospitals which had no connection either direct or remote with vivisectors. Further, that the Hospital Fund Committee had done this with the express object of encouraging so-called vivisection. Mr. Coleridge deduced the necessary corollary from this assertion, and stated point-blank that the Prince of Wales's Hospital Fund had simply been used to endow vivisection on a huge scale.

If we examine the facts we shall find that any hospital in London of any eminence whatever and performing philanthropic work of any magnitude, has upon its staff physicians and surgeons who have at one time or another experimented on animals. The small hospitals received small grants because their need was relatively small, and the large hospitals large grants because their need was relatively large, not because the former were unconnected and the latter connected with so-called vivisectors. Mr. Coleridge did not include in his speech the fact that he himself had endeavoured to strike a bargain with a London hospital, promising this institution the pecuniary support of the Anti-Vivisection Society if it would exclude from its staff all those whose medical knowledge had been derived from experiments upon living animals. The reply of this institution is worthy of record: it refused to allow any other considerations than those of medical or surgical efficiency to guide it in the choice of its officers.

This point has just now a very special interest, in that we believe that vivisection is to be made a party cry in the case of contributions to the Hospital Sunday Fund. Contributors are to be asked by the Anti-Vivisection Society when giving their contributions to demand that they shall only be devoted to hospitals having no connection with vivisectors or vivisection. So valuable have the results of experiments upon animals been to medical science that scarcely a hospital can be found independent of medical men who have derived their knowledge from them; and the Anti-Vivisection Society, with all its ingenuity and perseverance, cannot find amongst the ranks of its supporters a single medical man or indeed biologist of eminence. It is earnestly to be hoped that this fact will have its full weight with all contributors to hospitals, and that they will give their donations as they have done before, resting assured that their money will be duly apportioned by competent philanthropists accustomed to weighing justly the relative claims of charitable institutions, and not easily influenced by the clamourings, however loud, of ignorant partisans.

THE ARMY EDUCATION COMMITTEE.

WE are glad to learn that Sir Michael Foster has been added to the committee appointed to consider the present methods of selecting and training officers for the various branches of the Army. As stated in our number of May 2 (p. 23), this committee, as originally constituted, consisted of Colonel Jelf, Lieut.-Colonel Hammersley and Captain Lee, together with the Head Master of Eton, the High Master of St. Paul's, and the Right Hon. A. Akers-Douglas (chairman) and Captain Cairnes (secretary). Such a change as that which has been made was therefore very desirable, and we feel sure that the addition of a representative of science to the committee will meet with general approval.

As the methods of selecting candidates for the Army have been altered repeatedly during the last twenty years, and as the present regulations, which we owe largely to the exertions of Sir Henry Roscoe, came into action no later than November 1898, it is clear that only an exceedingly small proportion of our present officers have been selected under those regulations and that only a few of these can as yet have reached positions higher than that of a lieutenant. It is certain, therefore, that any defects that may have been detected during the trials of the last two years must, so far as they are due to systems of selection at all, be the outcome, not of the present system, but of those narrower schemes which preceded it, and which, as we pointed out again and again before they were altered, tended to exclude certain classes of candidates from a profession which they were well fitted to adorn. This defect was remedied by the regulations now in force, and we trust that whatever changes may be found necessary there will be no reverting at this critical moment to the narrower policies of the earlier scheme.

There is said to be a strong and, we would venture to add, a highly reasonable feeling on the part of leading military authorities that what the Army wants is a plentiful supply of able candidates. If this be true, as we hope it is, we trust that the committee may find themselves able to make recommendations which will enable clever candidates who may not happen to be endowed with private incomes, or to be cadets of well-to-do families, to enter the Army more freely in the future than has been possible in the past. And, secondly, that they will take care that any new scheme of examination they may propose shall have no tendency to restrict the field of selection, but offer reasonably equal chances, as the present scheme does, to candidates of all suitable types and aptitudes. It would be a national misfortune if any present necessity of the Army should be made the basis of changes which would tend to reproduce the conditions of ten or a dozen years ago.

STUDIES ON THE STRUCTURE OF THE UNIVERSE.[1]

A VERY interesting publication has recently been issued by Mr. Stratonoff, of the Russian Observatory at Tachkent, on the structure of the universe, a problem which has a fascination of its own for most readers quite apart from any real progress which may be made towards its solution.

The question is so vast that the researches of our greatest astronomers have done little more than lead us to the top of Pisgar and show us from afar the promised land, but every newly ascertained fact, or even confirmation of old ones, is a valuable contribution towards the general stock of knowledge which is being gradually accumulated, out of which, perhaps, the genius of some future Newton may evolve some general law.

Before any real advance can be made in the study of the structure of the universe, it is necessary to commence, and perhaps finish, with the Milky Way, that great band of faint stars which has puzzled mankind from the earliest times and which has been explained more according to the imagination of the observers than with any regard to the facts. Indeed, before the age of modern scientific instruments there were no facts to explain anything, and even now, with all our present resources, fresh facts are only being very slowly brought out; we still depend very largely on eye observations, only the eye we now use is the photographic camera.

We know in a general way that the galaxy is composed of very faint stars, presumably at an immense distance from our system, and that the stars have a tendency to thin out as we leave this region and approach the galactic poles. The great researches of Herschel, W. Struve, Argelander and Seeliger have thrown much light on the distribution of the larger stars as shown in the various catalogues; there, however, still remained the telescopic stars to deal with, and it is this part of the question that Mr. Stratonoff has taken in hand.

Mr. Stratonoff has devoted himself to the making of a series of charts showing the distribution of the stars in the northern hemisphere and down to 20° south, and for this purpose he has divided the part of the sky dealt with into 1800 separate areas, and tables are given showing the density of the stars in each. These particulars are represented in the maps by a colour scale by which the regions containing the largest number of stars may be seen at a glance.

The first eight maps show the distribution of stars to each half magnitude from the 6th to 9·5; and the well-known tendency of the stars below the 6th magnitude to leave the poles and crowd more and more towards the galactic equator is well shown in the case of each magnitude.

The Milky Way itself Mr. Stratonoff considers to be an agglomeration of immense condensations, or stellar clouds, which are scattered round the region of the galactic equator. These clouds, or masses of stars, sometimes leave spaces between them and sometimes they overlap, and in this way he accounts for the great rifts, like the Coal Sack, which allow us to see through this great circle of light.

Mr. Stratonoff also finds evidence of other condensations of stars in these maps; the nearest is one of which our sun is a member, chiefly composed of stars of the higher magnitudes, which thin out rapidly as the Milky Way is approached.

A second condensation is also found at a distance represented by the stars of magnitudes from 6·5 to 8·5, and a third, still further off, at about the distance occupied by stars of magnitudes from 7·6 to 8.

Mr. Stratonoff has also pushed his inquiries into the distribution of the stars according to their spectral type.

For the purposes of this inquiry the Draper Catalogue has provided the materials. In this catalogue the stars are divided into sixteen classes, known by letters from A to Q. In order, however, to facilitate mapping, Mr. Stratonoff has put all these classes into two:—Class I. embraces the divisions A, B, C and D, and Class II. takes in the rest. These two classes are too large to make these two maps of the distribution of the spectral types of much service, but they may be taken to give some rough idea of the position in the heavens of the stars of Secchi's types I. and II. From a glance at these maps it is seen that the stars of type I., which includes the Sirian and Orion stars, are situated principally near the Milky Way, while those of type II., which includes our sun, are principally condensed in a region coinciding roughly with the terrestrial pole, and only show a slight increase, as compared with other stars, as the galaxy is approached.

This mapping out of stars in their spectral classes is of the highest interest in the study of the structure of the universe, but we doubt whether the study of these types is sufficiently advanced to get any real information which can assist the student in this respect, and we must be content to wait until a far larger number of stars has been accurately observed before such maps can have anything more than a passing value. Mr. Stratonoff, however, has skilfully used the material he had, and we hope that he will take up this part of his subject later on.

[1] "Publications de l'Observatoire Astronomique et Physique de Tachkent. Etudes sur la Structure de l'Univers," par W. Stratonoff, Astrophysician de l Observatoire de Tachkent.

The atlas also contains five maps showing the distribution of the nebulæ in the northern and southern hemispheres according to the various classes into which they are generally divided. Mr. Stratonoff states that the law which operates to cause the galaxy to be poor in nebulæ is a general one and extends to all classes of these objects, bright, feeble, large and extended. The nebulæ, however, do not appear to have been studied from a spectroscopic point of view, as it is well known that the gaseous nebulæ are chiefly found in the Milky Way.

The last map is devoted to star clusters in both hemispheres, and shows that these objects are intimately connected with the galaxy, the globular clusters, as distinct from star clusters generally, being the only ones which show no tendency to accumulate in this region.

Mr. Stratonoff has executed a laborious piece of research, and we congratulate him on making so interesting a contribution to stellar literature. HOWARD PAYN.

THE GEOLOGICAL SOCIETY AND ITS MUSEUM.[1]

THE Geological Society of London, which was founded in 1807, began in early days to accumulate a collection of rocks and fossils, minerals and recent shells; and when, in 1828, the Society was provided with apartments in Somerset House, adequate space was afforded for the arrangement of the museum. Although many specimens were distributed throughout the rooms, two of these were specially set aside for the museum, an upper room containing the foreign specimens and a lower room mainly for the British rocks and fossils, while the minerals and recent shells were stored in cabinets in the smaller library. The museum then supplied a real educational want, and was of great service in preserving specimens which illustrated many of the papers read before the Society and published in its *Transactions*. Its state may be judged of from the Report of the committee in 1836; they express "the pleasure they derived from the excellent state of preservation of the whole museum, and from the unwearied zeal and discriminating skill displayed by the curator in arranging the collections." For fourteen years William Lonsdale devoted himself to the welfare of the Society, not only reorganising the museum but editing the publications. He retired in 1842 and was succeeded by Edward Forbes. There is no doubt that in those days the museum was fully appreciated, and the lower room particularly, with its cosy fires, was in winter time a pleasant resort for conversation and study.

Meanwhile, however, the work of the Society increased, the library growing especially, while the museum made little progress, and although a curator (who gave his whole time to the museum) was now and again appointed for a period, it was not possible to offer remuneration sufficient for the purpose; and increasing difficulty was felt in keeping the collections properly named and in proper order. In 1868 the Council "decided on the discontinuance of the formation of a general collection," and restricted it "in future to specimens illustrative of papers read before the Society and those received from abroad." In 1874 the Society removed to its present rooms in Burlington House, and took the opportunity to present "superfluous duplicates" to the British Museum, the Museum of Practical Geology and other institutions. Since this date, however, the museum, while occupying valuable space, has been of comparatively little service to science or to any of the fellows. The collection, as a whole, has been sadly neglected, owing to the fact that the other work of the Society has fully occupied the officers. It has been realised, too, that the want which the Society in its earlier days supplied was now better supplied elsewhere, and that the fellows have ceased to take much personal interest in the museum. As Sir John Evans remarked, in his address to the Society in 1875, "the best home for a collection of British specimens was at the headquarters of the Geological Survey" in the Museum of Practical Geology. In 1896 a proposal was made to transfer great part of the Geological Society's collection to the British Museum, but the transfer was not then agreed to. On March 27 of the present year a special general meeting of the Society was again called to consider the matter, and it was then resolved "That in the opinion of this meeting the time has now come when this Society shall transfer its collections to some other museum." That this is a wise resolution most of those who know the museum and value its contents will cordially agree. Nor is this view inconsistent with the possession of a considerable amount of sentiment for the museum and its associations with the early history of the Society, with Greenough, Lonsdale, Fitton, Murchison, Leonard Horner, Daniel Sharpe, Falconer and others who actually worked in the museum or largely contributed to its stores. Those inspired with such sentiment would prefer to see the specimens well taken care of and accessible. It is reckoned that there are 2460 figured or described fossils. In the interests of geological science it is desirable that these be placed in the British Museum, Cromwell Road, where as many type-specimens as possible should be deposited; and it would not be difficult to find appropriate resting-places for all other specimens worthy of preservation.

The question is simply this: How can the specimens in the museum be best dealt with in the interests of geological science? And we hope the Society will soon settle it to the satisfaction of the fellows and of geologists in general.

[1] An article on "The New Museum of the Geological Society" at Burlington House, appeared in NATURE for January 20, 1876, p. 227.

THE ROYAL SOCIETY CONVERSAZIONE.

THE conversazione held at the rooms of the Royal Society on May 8 was a very successful one, and a large gathering assembled to examine the many interesting objects contributed by the fellows and others. We regret that the pressure on our space does not permit the publication of the various explanations carefully given in the official catalogue. But some of the more important of the exhibits have already been referred to in our columns, and we propose to return to more of them later on.

Mr. J. E. S. Moore, the Tanganyika problem. This exhibit was intended to give some idea of the additions which have been made by Mr. Moore, during the second Tanganyika Expedition, to our knowledge of the faunæ in the great African lakes.

Dr. H. E. Annett and Mr. J. E. Dutton, of the School of Tropical Medicine, University College, Liverpool: (1) Specimens of some new blood Filariæ, (2) specimens illustrating the life-history of *Ankylostoma duodenale* of the Chimpanzee. Mr. J. Mackenzie Davidson: (1) Stereoscopic transparencies of electrical discharges, and (2) skiagrams of bullet wounds. Mr. Eric S. Bruce, the meteo-parachute, a new instrument for investigating the upper atmosphere.

Commander D. Wilson-Barker, cloud photographs. Prof. J. W. Judd, F.R.S., on behalf of the Coral Reef Committee of the Royal Society, specimens of Foraminifera and Ostracoda, from Funafuti, Ellice Islands. Mr. H. J. Elwes, F.R.S., reversible drawers of butterflies from the Holarctic Region arranged to show wide distribution and adaptability to extremes of climate. Also to show variation and difficulty of applying binomial system of nomenclature. Mr. Killingworth Hedges, fulgurites, or lightning tubes, from the sand hills at Kensington, N.S.W.

Mr. J. E. Barnard and Dr. Allan Macfadyen exhibited luminous bacteria (from the Bacteriological Laboratory of the Jenner Institute of Preventive Medicine). The luminous bacteria are a group of organisms, whose natural habitat is sea-water. They are the cause of the so-called phosphorescence to be seen at times on such objects as dead fish, meat, or other substances which are suitable soils for their growth and development. Their luminous properties are dependent on a supply of free oxygen and a suitable percentage of a soluble chloride in the nutritive medium. The exhibit consisted of artificial cultivations of these organisms on suitable nutrient soils, and showed their luminous properties and the variations that occur under different physical conditions.

Mr. Everard im Thurn, C.B., C.M.G., exhibited arrow-heads of rock crystal from British Guiana, and orchids growing wild in British Guiana; Mr. Vaughan Cornish, photographs of waves, &c., in sand, cloud and snow; Mr. J. Wimshurst, F.R.S., photographs which exhibit some of the properties of the light emitted by Röntgen ray tubes; Mr. Hugh Ramage, diagrams of corresponding lines in homologous spectra; the Meteorological Office, pilot charts of the North Atlantic and Mediterranean for April and May, 1901; the Cambridge Scientific Instrument Company, Ltd., Callendar and Griffith's patent temperature indicator, and photographs of the spectroscope, made for Sir David Gill, for use with the McClean telescope, Royal Observatory, Cape of Good Hope; and the Carl Zeiss Optical Works, stereoscopic binocular range-finder. The reading is taken direct from a scale within the instrument without calculations, giving the distances in meters. Range from 75 to 3000 meters; Prof. J. C. Bose, experiments on binocular alternation of vision; and Mr. R. Shelford, swords and knives from Sarawak, Borneo.

The Director, British Museum (Natural History), exhibited models illustrating the structure of the gills of bivalve mollusca; examples of mormyrid fishes from the Nile; a series of adult and young birds and eggs of the Adelia penguin (*Pygopcelis adeliae*); trephined skulls of natives of the Bismarck Archipelago, collected by the Rev. J. Crump and deposited in the British Museum by Mr. W. E. de Winton. These skulls illustrate native methods of performing the operation of trephining, and are of especial interest owing to the clinical histories of their owners being known. Claw and tooth of Neomylodon Patagonia, and coloured model of the right whale; Prof. A. G. Greenhill, F.R.S., showed a reflecting stereoscope; trochleostatic—diagram and models of pulleys; Mr. C. V. Boys, F.R.S., tool grinding appliance; Dr. Dawson Turner, a mechanical interrupter for an induction coil; and the Marine Biological Association, examples of marine plankton from the neighbourhood of Plymouth. The term marine plankton is used to denote organisms whose normal mode of life is to swim freely in the sea-water, in contradistinction to such as live in contact with the sea-floor. The Observatory, Cambridge, exhibited a machine for measuring astronomical photographs; and Prof. Callendar, F.R.S., a standard barometer.

Photographs of Nova Persei were exhibited by Sir Norman Lockyer, K.C.B., the Rev. W. Sidgreaves, S.J., and Mr. Frank McClean, F.R.S.

The Zoological Society of London exhibited living specimens of the Heloderm (*Heloderma suspectum*) from Arizona, the only venomous lizard known; Dr. J. H. Gladstone, F.R.S., ancient Egyptian gold; Mr. W. Flinders Petrie, casts and photographs of Egyptian jewellery of the 1st dynasty, 4700 B.C., and specimens of molecular transference in ancient bronze; Prof. A. W. Rücker, Sec. R.S., and Prof. J. W. Judd, C.B., F.R.S., specimens of atmospheric dust which fell at Taormina, Sicily, during the month of March, giving rise to the so-called "blood rain"; Sir W. Roberts-Austen, K.C.B., masses of chromium, manganese, ferro-titanium and cobalt. These specimens of metal were reduced from their oxides by means of finely divided aluminium, by Dr. Hans Goldschmidt.

Dr. P. L. Sclater, F.R.S., exhibited two bandoliers from the Semliki Forest, Congo Free State, made from the skin of a new mammal; Dr. H. Woodward, F.R.S., coloured casts of objects of natural history, prepared at the British Museum (Natural History); an enlarged model of the shell of Ascoceras, a cephalopod occurring in the silurian rocks of England, Sweden and North America; and table of British strata, coloured; Mr. G. Abbott exhibited symmetrical concretions, and "growth" in inorganic matter. Also specimens of four varieties of the cellular or magnesian limestone of Sunderland (Permian), which show a striking resemblance to corals, yet are believed to be only concretionary and inorganic. Hon. Walter Rothschild, M.P., exhibited leg bones and egg of *Æpyornis titan*, Madagascar; Mr. W. Duddell exhibited the musical arc. If a *direct current* arc between *solid* carbons be shunted by a suitable self-induction and condenser in series, alternating currents will flow round the shunt circuit, the arc thus converting part of the direct current into alternating current. The frequency of the alternating current is determined, as in the case of the oscillatory discharge of a Leyden jar, by the capacity and the self-induction of the circuit. These alternating currents superposed on the direct current through the arc will cause it to emit musical notes, the pitch of which can be varied by altering the capacity or self-induction, and a tune can be played on the arc by this means.

The Telegraphone Syndicate exhibited the telegraphone. This instrument, the invention of Mr. Poulsen, of Copenhagen, depends for its action upon the fact that the variations of the magnetic field of an electro-magnet are so accurately represented by the magnetisation of a steel wire which is drawn through it, that if the wire be again passed through the field, currents exactly similar to those which produced the magnetisation of the wire are reproduced in the coils of the magnet. This principle has been applied to the reproduction of speech transmitted through an ordinary microphone transmitter.

The following demonstrations were given by means of the electric lantern:—Dr. Arthur Rowe, life-zones in the White Chalk, and their significance in connection with the evolution of species; Mr. Francis Fox, some engineering problems and their solution; Prof. Silvanus P. Thompson, F.R.S., kinematograph diagrams, illustrating magnetic fields.

THE NATIONAL ANTARCTIC EXPEDITION.

PROF. J. W. GREGORY has to-day (May 15) cabled his resignation of the leadership of the scientific staff of the National Antarctic Expedition in circumstances which will shortly be fully explained to the Fellows of the Royal Society by one of their number.

The great majority of scientific men in this country were confident that Prof. Gregory possessed unique qualifications for the post of scientific leader of an expedition in which many branches of science required study and coordination. Under his direction, and with a competent naval head who should have an absolute veto upon all operations which involved risk to ship and crew, great scientific results were assured.

The opposition of the representatives of the Royal Geographical Society, which had obtained most of the funds voluntarily subscribed, and of a few scientific men belonging to the Navy, rendered it impossible that these full powers could be granted; but a compromise acceptable to Prof. Gregory was passed by a large majority (16 to 6) of the Joint Antarctic Committee, including the officers of both societies and almost every expert on their joint lists.

The compromise provided, in the words submitted on February 12 to the joint committee, "that a landing party, if possible, be placed on shore, under the charge of the Director of the Civilian Scientific Staff." Prof. Gregory was informed of this, accepted it, and, the next day, sailed for Melbourne.

The Royal Geographical Society's council refused to accept the compromise, and deputed three of their number to suggest to the officers of the Royal Society that the matter should be settled by a new committee of six, three to be appointed by each council. The Royal Society consented; the committee, chiefly composed of non-experts, met, and proposed modifications which Prof. Gregory has been unable to accept.

We shall await with some interest to see whether the majority of Fellows of the Royal Society, and of other scientific men in this country, will approve the manner in which the Royal Society has acted as the guardian of scientific interests.

NOTES.

INTELLIGENCE has just reached us from Melbourne that on April 10 news had been received from Charlotte Waters, both by letter and telegram, of the safety of Prof. W. Baldwin Spencer and his energetic co-explorer, Mr. Gillen. They report themselves in good health and already busy taking phono- and kinematographic records; and it is good news that the Postmaster-General of South Australia has provided them with a pocket apparatus for tapping the overland telegraph line when in the vicinity of their route. We are also informed that during Prof. Spencer's absence some of his duties are being partly performed by Miss Ada M. Lambert, a distinguished student of the Melbourne University, whose name and work will be well known to all who follow the progress of zoology at the Antipodes.

Dr. Gustav Zeuner, of Dresden, has been elected a correspondant of the Paris Academy of Sciences, in the section of mechanics. Dr. Oudemans has been elected a correspondant in the section of geography and navigation.

One noteworthy feature of the modern educational revival in this country is the gradual conversion and development of the older grammar schools so as to bring them more into harmony with the requirements of the time. Among the latest examples of this enlightened policy is the King's Middle School at Warwick, one of the most ancient foundations in the country. Its founder is said to have been Lady Ethelfleda, daughter of King Alfred, and in date it is coeval with the castle, although the present buildings are modern. The School was opened on May 4 as a School of Science by Sir George Kekewich, who addressed a large meeting in the central hall, in the course of which he said that "science had now come to be regarded as a proper part of the education of every man, in whatever class he might be and in whatever position of life." He added also, among other pregnant remarks, that "it was the new knowledge in science that paid. It was the new knowledge that preserved the nation that produced it in the forefront of commercial and industrial supremacy." The Earl of Warwick, chairman of the board of managers, presided at the meeting, and gave in his opening remarks a brief account of the history of the School and the origin of the present development. The expense of building the new laboratories, &c., has been partly met by a contribution from Sir Thomas White's Charity and partly by a grant from the County Council. Among other speakers who addressed words of encouragement to the managers and scholars were the Countess of Warwick, Dr. Oliver Lodge, representing the nearest University (Birmingham), with which he hoped to see the school hereafter affiliated, Prof. Meldola, Mr. Bolton King, chairman of the Warwickshire Technical Instruction Committee, the Mayor of Warwick, Mr. Alderman Glover and others. The head-master is Mr. H. S. Pyne, who in organising the curriculum hopes to include the scientific subjects bearing upon agriculture, this being the predominant industry in the districts immediately contiguous to the ancient county town. The mining industry is already provided for by a mining school, established elsewhere by the County Council.

The conversazione of the Society of Arts will be held this year at the Royal Botanic Gardens, Regent's Park, on June 28.

Mr. Reginald Smith, of the British Museum, has just conducted a second excavation on the Winklebury Estate, Basingstoke. He found fragments of pottery, which he said undoubtedly belonged to the ancient British period, *i.e.* before the Roman invasion of Britain.

The eighty-fourth annual meeting of the Swiss Natural History Association will be held at Zofingen on August 4–6. At the same time and place, the Swiss Geological, Botanical and Zoological Societies will hold their meetings. Intending visitors should send their names before July 15 to Herr Ulr. Ammann, Zofingen.

The death is announced, on April 8, of Giulio Bizzozero, professor of pathological anatomy of the University of Turin. Bizzozero was born on March 20, 1846, and was elected a fellow of the Accademia dei Lincei on November 12, 1883, and became a senator of the Italian Government in 1890. His best known discoveries refer to the spinous cells of the epidermis, the functions of the medulla of the bones, the intestinal epithelium, and the morphological elements of blood. He founded a school of histology for Italy, and included Golgi among his pupils.

A few days earlier, on April 5, the Accademia dei Lincei was bereft of its president, Signor Angelo Messedaglia, who was born on November 2, 1820, and obtained the fellowship of the Accademia in 1875. Messedaglia's speciality was political economy and statistics, but his knowledge also embraced modern and ancient literature, history, mathematics, astronomy, geography and physics. His last work on Homeric uranology bears abundant testimony to his wide range of study and careful reasoning. He preserved his full activity and intellect nearly till his death.

The steps taken to provide a memorial of Dr. Walter Myers, who lost his life at Para on January 20 from yellow fever, caught while investigating that malady for the Liverpool School of Tropical Medicine, were explained at the last meeting of the committee of the School. The committee has offered to erect memorial brasses in University College, Liverpool, and in Birmingham University, and the offers have been accepted. The School has also erected a tombstone over the grave of Dr. Myers at Para. It has been resolved to found, as a permanency in the School, the Walter Myers Chair of Tropical Medicine, besides a supplementary fellowship for the next five years, to be called the Walter Myers Fellowship of Tropical Medicine.

The Whitsuntide excursion arranged by the Geologists' Association is to the new line of the Great Western Railway from Wooton Bassett to Filton, and the district around Bristol. The party will leave Paddington Station on Saturday, May 25, and return in the following week. Many sections, beds, and other features of geological interest will be examined, and the excursion will be enjoyed by all who take part in it. The Yorkshire Naturalists' Union have arranged an excursion to Brough on Whit-Monday for the investigation of Welton, Elloughton and Brantingham Dales, and the southern extremity of the Yorkshire Wolds.

We are pleased to learn from *Science* that the Legislature of the State of Wisconsin has presented to Dr. S. M. Babcock, of the University of Wisconsin, a fine bronze medal "recognising the great value to the people of this State and the whole world" of his inventions and discoveries, "and his unselfish dedication of these inventions to the public service." Scientific work is so often overlooked by the State that it is pleasing to record the recognition of it. Dr. Babcock's renown rests largely upon his milk test, which has proved of immense value in the dairy industry, but to men of science, who are familiar with dairy and agricultural investigations, his many discoveries in these fields are regarded as even more brilliant and of more value to science than the invention for which he has now been honoured.

The educational and scientific sides of war will receive special attention at the Naval and Military Exhibition shortly to be opened at the Crystal Palace. Demonstrations will be given of wireless telegraphy, the Röntgen rays and other scientific experiments applied to the uses of war in the Army and Navy. The use of the balloon in military operations will be demonstrated; and a special interest attaches to this section, as Sir Redvers Buller is lending the balloon employed by him during the siege of Ladysmith. In connection with this section, and naturally forming part of it, will be an exhibition of war kites, the uses of which will be shown. In an "Arctic" section there will be, not only a large collection of Arctic relics and pictures, but also a tableau illustrating Nansen's polar expedition. In the inventions section a series of the latest and most valuable applications of mechanical science to the needs of the Army and Navy will be on view.

A CHRISTIANIA correspondent of the *Times* reports that the second international Hydrographic Conference held its final meeting on Saturday. The object of the Conference was to complete the international programme of research and the plan of organisation drafted in Stockholm in 1899. The original programme has been revised to meet the wishes of the participating Governments, and it is believed that the new proposals will command such general approval as to permit of the commencement of international investigations at an early date. The Governments of all the countries bordering on the North Sea and the Baltic were represented at the Conference, except France, the geographical position of which gives her less practical interest in the area of research. The Norwegians and Russians have already provided themselves with special steamers adapted to the proposed investigations, and a German steamer is now being built. The arrangements of most of the smaller States are well advanced. It is believed that it now rests with the British Government to decide whether the international programme shall be carried out or not.

THE *Revue Scientifique* contains an account of the first meeting of the "Association Internationale de la Marine," held from April 12 to 15 in the building of the oceanographical museum at Monaco. Amongst the more important communications received was one by H.S.H. the Prince of Monaco on the meteorological service of the Azores, which has recently been actively taken up by the Portuguese Government and is now to be carried on on a very adequate scale at an annual cost of 45,000 francs. M. Charles Bénard, president of the Société d'Océanographie du Golfe de Gascogne, contributed a paper on improvements in the equipment of vessels in case of shipwreck, his proposals embodying, in particular, the suggestions of the Prince of Monaco with regard to proper fishing appliances in ships' boats. M. Thoulet's lithological map of the coasts of the Seine Inferieure was presented, and a resolution urging the need for preparing such maps of all frequented coasts, in the interest both of navigators and fishermen, was adopted. The Congress also declared itself in favour of the establishment of a permanent Bureau Maritime Internationale, which should concern itself with all maritime affairs of international interest, lighting and buoyage, regulation of fisheries, assistance of sailors and the like. The Prince of Monaco, at the earnest invitation of the Congress, agreed to take the initiative in attempting to bring about the formation of the proposed organisation.

THIS year's Deutscher Geographentag will open at Breslau on Monday, May 27. On the morning of May 28 Prof. Neumayer will present the report of a committee upon Antarctic exploration, and will speak upon magnetic investigations in polar regions. Dr. E. Philippi will deal with the geological problems of the German Antarctic expedition, and Prof. A. Supan with the Antarctic climate. At the second sitting the subject to be discussed is the organisation of geographical instruction, the speakers being Prof. H. Wagner, Dr. Auler and Herr H. Fischer. On Wednesday morning, May 29, the subjects to be brought before the meeting relate to the scientific study of lands and native races of German colonies. The speakers will include Prof. F. v. Richthofen, Prof. G. Volkens, Dr. E. Kohlschütter, Prof. K. Dove and Prof. Schenck. The methods of geographical instruction will be discussed in the afternoon of the same day by Dr. A. Becker, Prof. A. Fischer, Prof. A. Kirchhoff, Prof. Langenbeck and Prof. A. Bludau; demonstrations will also be given by Prof. K. Dove and Dr. M. Ebeling. In the evening an illustrated lecture will be given on glacier markings in Montenegro, by Prof. K. Hassert, and one on the volcanoes of central France by Dr. M. Friederichsen. At the fifth sitting, on May 30, the papers will deal with various aspects of glaciers and glaciation, and the speakers will include Profs. Finsterwalder, H. Meyer, S. Günther, A. Penck, W. Goetz and Dr. W. Halbfass. On the afternoon of the same day, reports and papers will be received from Prof. A. Kirchhoff and C. M. Kan, and Dr. K. Sapper; and the general business of the association will be transacted. Excursions have been arranged for a few days at the end of the meeting, and exhibits of geographical interest will be on view in two museums in Breslau. The general secretary, with whom intending visitors should communicate, is Dr. R. Leonhard, Schillerstr. 28, Breslau.

IN the *Journal* of the Quekett Microscopical Club Mr. J. Rheinberg describes a simple contrivance for viewing, under the microscope, the diffraction patterns of diatoms and other objects of similar structure. The method adopted by Dr. Johnstone Stoney is to look at the objective through a small hole fixed near the usual place of the eyepiece. Mr. Rheinberg finds that the diffraction patterns can be better seen above the eyepiece by fixing in a short tube the objective of one of the 7*s.* 6*d.* toy microscopes, which is a lens of about ½-inch focus, stopped down to an aperture of about 1 mm. This arrangement, placed over the ordinary eyepiece, shows the diffraction patterns magnified, and, further, it gives plenty of light, and the patterns cannot shift.

A VERY convenient addition to the laboratory or workshop equipment is the rosin-cored solder recently introduced by the Patent Solder Co., Ltd. This commodity is guaranteed to consist of pure metals mixed in the most efficient ratio, and, as its name implies, has incorporated with it the requisite amount of rosin so that no additional flux is necessary. This is attained by making the solder in the form of a tube with narrow bore, the central cavity being occupied by the flux. The two ingredients being together will facilitate work in difficult positions, and the cleanliness in working will be found a special recommendation for electrical work. The solder is made in four sizes, each of three qualities. The sizes vary from 1/16th to ¼-inch diameter.

THE *Physical Review* for March contains an article by Prof. Carhart on the various determinations of the E.M.F. of the Clark cell. The value originally obtained by Clark reduced to present units at 15° C. is 1·4378 volts, but subsequent research has shown that this is somewhat too high. Prof. Carhart summarises the results of eight other determinations of this constant, in five of which the value was obtained by the use of the silver voltameter, the remaining three values being obtained by absolute methods. The mean value calculated from the whole eight determinations is 1·4335 volts at 15° C., and the mean of the three absolute determinations is 1·4333 volts. Prof. Carhart concludes that the true value is nearer 1·433 volts than the generally accepted value of 1·434 volts. This conclusion is borne out by the results of two determinations of the mechanical equivalent of heat by electrical methods, in both of which the values obtained are higher than those given by direct mechanical methods; if the E.M.F. of the Clark cell is taken as 1·433 volts instead of 1·434, the discrepancies almost disappear.

THE same journal contains an interesting article by Mr. Carl Kinsley on the measurement of the sensitiveness of coherers for wireless telegraphy. Mr. Kinsley urges the desirability of some standard method of comparing coherers so that the work of different experimenters may be compared, and suggests two ways in which this may be done. Coherers may either be compared relatively by measuring the height of vertical wire necessary for them to respond to signals sent by a given transmitting apparatus at a given distance, or, absolutely, by measuring the voltage at which their initial resistance breaks down. The two methods, it is pointed out, always give the same relative results; the latter appears to be preferable as it is more easily carried out, and, moreover, eliminates all errors which might arise through differences in the transmitters, which is especially advantageous in the case in which the work of different persons is being compared. Mr. Kinsley rightly insists that the absolute value of the resistance after the breakdown, whether high or low, is not of much importance, as the relay can always be designed to work well with the particular coherer with which it is intended to use it.

WE have received from the Rev. J. Coronas, S.J., of the Manila Observatory, a discussion of a cyclone (*El baguio del* 8 *de Septiembre*, 1900) which traversed the centre of the island of Luzon and is said to have been the most severe storm experienced during the previous six years. It is satisfactory to note that, notwithstanding the paucity of observations from other stations owing to the disturbed condition of the island, the observatory was able to give notice of the existence of the disturbance in the Pacific three days before its arrival on the coast. The observations are insufficient to determine the track of the storm across the Pacific, but after leaving the west coast of Luzon it took a north-westerly course and, crossing the China Sea, reached the mainland near the north of Hainan on September 11. The fall of the barometer was greatest, and the winds the most violent, in the rear of the cyclone; a considerable rise of the barometer was observed at all stations in the front of the disturbance, and was correctly interpreted as a bad sign. The rise was much more rapid than the subsequent fall. The author discusses at some length the premonitory signs of such disturbances, particularly convergence of cirrus clouds and the swell of the sea; the latter is at times observed some 500 miles in advance of the approaching storm.

IT is reported that an American citizen and a member of the Roman Catholic Church has offered to present to the Pope a telescope larger than that shown at the Paris Exhibition of last year. His Holiness is stated to have accepted the gift, which is now destined to find a prominent place amongst the many valuable instruments of research of the Vatican Observatory, which was presented, just over a century ago, by Cardinal Zelada with the then famous Dollond's telescope. Referring to this gift, the *Lancet* gives some interesting particulars concerning the Vatican Observatory. There seems to be scarcely any doubt that an observatory tower was erected in Rome so far back as some time previous to 1582, and, as it would appear, chiefly in connection with the reform of the Calendar. According to B. Crescenzi, Pope Gregory XIII. was mainly responsible for its erection. It is recorded that the tower was intended exclusively for astronomical observations and researches, and there is, from an historical point of view, every reason to suppose that it was the first celestial watch-tower ever built in Rome. Since its erection, however, and partial endowment by Pope Gregory XIII., it has passed through many and highly complicated vicissitudes. It became of world-wide renown at the beginning of the last century, chiefly on account of the scientific labours and able management of Philip Gili, who, for a period extending over thirty years, was its director. After the death, however, of Gili, which occurred in 1821, it again became quite disorganised. In 1888 the Vatican Observatory commenced a new epoch in its history. In that year the commemoration of the fiftieth anniversary of the priesthood of Pope Leo XIII. took place, and on that occasion all the instruments and apparatus given by members of the Roman Catholic Church interested in celestial and terrestrial physics were brought together, and it then occurred to the organisers of the science section of the Vatican Exposition that they would find a suitable home in the old Gregorian tower. The suggestion was warmly approved and soon carried into effect, and the Observatory has since then taken a place in the first rank.

THE new number of the *Mitteilungen aus den deutschen Schutzgebieten* is, as usual, largely devoted to statistics of meteorological observations and astronomical determinations of positions. A map of East Usambara, on a scale of 1 : 50,000, based on trigonometrical and topographic surveys, accompanies the number, also sketch-maps from surveys of the Kirunga volcano region, and of the Ramu river in New Guinea. There are short articles referring to the maps, and Count Zech contributes an illustrated paper on the production of kola in West Africa.

THE *U.S. Experiment Station Record* states that the agricultural council of the Russian Ministry of Agriculture and Imperial Estates has taken steps in the direction of improving the character of the live stock and the live-stock industry in general of that country. At present this industry is said to be far behind that of other countries, the animals kept being inferior and stock raising receiving comparatively small attention from the farmers. The council has recommended the holding of live-stock shows, with prizes for excellence, the establishment of breeding farms and furnishing of expert assistance in purchasing good breeding animals, the maintenance of local breeding establishments where the service of pure-bred animals can be secured, and loans to municipalities and societies for the purpose of purchasing pure-bred animals and providing for their care. In order to carry out the above measures the Ministry of Agriculture, with the concurrence of the Minister of Finance, has recommended a grant of 5,000,000 roubles (about 500,000*l.*) to begin this work and a quadrennial grant of about 112,500*l.*

THE *Bollettino* of the Italian Geographical Society contains part of a paper by Prof. Gabriele Grasso on the distribution of place-names in the Italian communes, dealing specially with those names which have the word "monte" either as prefix or suffix. Dr. Cosimo de Giorgi contributes an elaborate discussion of the physical geography and geology of the port of Brindisi, and Dr. Giuseppe Stegagno a note on the lakes of the Euganean Hills. With this number is issued the part of the *Bibliografia geografica della regione Italiana*, by L. F. de Magistris, for 1899.

IN his Annual Progress Report of the Geological Survey for the year 1899 (1900) Mr. A. Gibb Maitland points out that the field-work has been carried on in areas occupied by the ancient crystalline rocks, presumably Archæan, where the work has had a direct bearing on economic questions. The Kanowna mining district to the north-east of Coolgardie was reported on by Mr. T. Blatchford. Here the schists, which are much decomposed, are in places highly auriferous, the granitic rocks and the interlacing quartz veins are also auriferous, as well as the alluvial deposits. The parent sources of the gold are the quartz veins and lodes which traverse the crystalline rocks, but there is much gold of secondary origin filling fissures or diffused over cleavage planes. It is remarked that what may be called secondary gold has been deposited from solution, not only in the alluvium and other superficial deposits, but also in the zone of decomposition of the bed rock.

MR. C. S. MINOT has sent us a paper, reprinted from *Science*, in which he describes and illustrates the unit system of laboratory construction. The idea is that the essential requirement of a building intended for laboratory work is a number of rooms of uniform and moderate size, abundantly lighted and conveniently accessible. The size proposed is 23 × 30 feet, and a room of these dimensions will provide working space of 3 feet 6 inches × 5 feet for each of twenty-four students, as well as sufficient space for general use. The only exceptions to the unit-rooms would be the lecture-rooms. It is evident that if an architect has merely to fit rooms of uniform size in a building his designs need only be of a very simple character, and he is, at the same time, given great freedom as to the exterior, which, as Mr. Minot remarks, seems as important to him as the interior is to the users of a building. Many advantages are attached to the unit system of laboratory construction, among them being adaptability and seclusion; and with regard to the construction Mr. Minot states that the cost of a building on the unit plan would be less than for one of equal capacity, but with rooms of the customary irregularity of size.

IN the *Irish Naturalist* for May Dr. R. F. Scharff records from Sligo a woodlouse (*Armadillidium pulchellum*) new to the British fauna. It is typically a northern form, ranging from Scandinavia to Belgium.

NUMBERS 1 and 2 of the fifteenth volume of the *Memorias* of the Society "Antonio Alzate" contain a continuation of the "Alphabetical Cross-reference Catalogue" of the works of the late Prof. Cope. The disadvantage of the mode of quotation adopted is that it is exceedingly difficult to find out which items are the original titles of the papers mentioned. Misprints are also noticeable.

TO the April number of the Johns Hopkins *University Circulars* Dr. C. Grave communicates an important geological and economical study of the oyster-reefs of North Carolina. The author describes the manner in which the oyster-banks of the district in question become, like coral-reefs, gradually converted into islands; and points out that some of the islands in Newport River still display their foundation of oyster-shells, while others exhibit the gradual transformation of an oyster-bank into an island. It is also shown that the history of these reefs affords indications of the proper mode of establishing new oyster-beds for economic purposes. Practical application of these principles has been made, with the result that oyster-culture is now successful in localities where previous attempts to start it had resulted in failure.

IN the *Revue Scientifique* of May 4, M. H. Coupin continues his essay on bird-song, dealing in this section chiefly with birds that imitate sounds other than their own. Very remarkable is the instance of a sparrow imitating the stridulation of the grasshopper. One spring a cage containing a sparrow was hung side by side with another in which were grasshoppers. No notice was taken by the sparrow of his neighbours, but next year, when he was again in the same society, he essayed the grasshoppers' chant. And for the rest of his life, when the grasshoppers had long been dead, the sparrow was accustomed to utter a polyglot song combining the notes of the insect with those of other birds. The fact that young linnets will sometimes learn the song of the nightingale instead of their own is mentioned. And it is also stated that several kinds of birds in Thuringia sing much better than the members of their own species dwelling in the Hartz Mountains.

THE *Zeitschrift* of the Berlin Gesellschaft für Erdkunde devotes the whole of the sixth number of the present volume to a paper on the climatology of Morocco, by Dr. Theobald Fischer. In this paper, which is the completion of the work recently published by the author in an Erganzungsheft of *Petermann's Mitteilungen*, the meagre data available for the region are discussed with great skill and made the foundation of a quite satisfactory outline of its climate. A rainfall map forms an important feature. The seventh number of the same volume contains a short paper, with some good illustrations, on the Rocky Mountains and the Sierra Nevada, by Dr. Emil Deckert, and Dr. S. Passarge contributes a valuable account, with maps, of his geological work in British Bechuanaland.

PROF. W. C. M'INTOSH sends us a copy of his article on the coloration of marine animals which appeared in the *Annals and Magazine of Natural History* for March. While admitting that in certain instances the coloration is for the purpose of protection, the author shows that in many cases it is very difficult to accept such an interpretation as the true reason. In the case of pelagic organisms, for example, where the transparency or faint coloration is assumed to be for protective purposes, he points out "that many of the surface-animals are there only for a limited period during fine weather, and disappear into the depths on the advent of storms and cold." The dog-whelk and the cowry (especially when the soft parts are extruded) are cited as creatures that are fairly conspicuous between tide-marks, and it has yet to be proved that they possess "warning colours." The fact that some cetaceans have their flippers or areas on their bodies white, while others are wholly black, seems to demonstrate that their coloration is not protective, this being supported by the conspicuous nature of a black mass exposed above the surface of the sea. The whole subject, in the author's opinion, demands careful revision.

WE have received vol. xxxii. of the *Proceedings* of the London Mathematical Society, containing papers read at meetings during the first half of last year. The publisher is Mr. Francis Hodgson, Farringdon Street, E.C.

THE Priestley Club, Leeds, has published a list of papers read at its meetings from November 1887 to April 23 of this year. The list shows that many subjects of great scientific importance have been brought before the Club, but we are not able to find whether the papers have been published, and if so, where they can be found.

MESSRS. CASSELL AND CO. have published a new edition (the ninth) of "The North-West Passage by Land," by Viscount Milton and Dr. W. B. Cheadle. The book contains the narrative of an expedition across North America, through the Hudson's Bay Territories, into British Columbia, by one of the northern passes in the Rocky Mountains. It originally appeared in 1865, and gives an interesting description of scenes and adventures in the great country of the Canadian North-West nearly forty years ago.

THE additions to the Zoological Society's Gardens during the past week include two Verreauxi's Guinea-fowl (*Guttera edouardi*) from East Africa, presented by Mr. W. L. Sclater; a Polecat (*Mustela putorius*), British, presented by Mr. F. D. Lea Smith; a Slowworm (*Anguis fragilis*), British, presented by Mr. H. J. M. von Löhr; a Black-handed Spider Monkey (*Ateles geoffroyi*) from Central America, a Kinkajou (*Cercoleptes caudivolvulus*) from South America, a Nylghaie (*Boselaphus tragocamelus*, ♂) from India, a White-browed Amazon (*Chrysotis albifrons*) from Honduras, a Tuberculated Iguana (*Iguana tuberculata*) from Tropical America, twenty-nine Barbadian Anolis (*Anolis alligator*) from the West Indies, four Hybrid Macaws (between *Ara macao* and *A. militaris*), bred in Italy, two Dark Green Snakes (*Zamenis gemonensis*), an Undulated Lizard (*Sceloporus undulatus*), three Brown Newts (*Spelerpes fuscus*), two Spectacled Salamanders (*Salamandrina perspicillata*), European, deposited; two Pintails (*Dafila acuta*), European, purchased; a Japanese Deer (*Cervus sika*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET a (1901).—A circular from the Centralstelle at Kiel furnishes the elements and a short ephemeris of the comet computed by Prof. Kreutz from the Cape observations.

Elements.

$$T = 1901 \text{ April } 24{\cdot}2614 \text{ Berlin M.T.}$$
$$\left.\begin{array}{l} \omega = 202^\circ\ 50'{\cdot}0 \\ \Omega = 109\ \ 57{\cdot}2 \\ i = 131\ \ 26{\cdot}0 \end{array}\right\} 1901{\cdot}0$$
$$\log q = 9{\cdot}38848.$$

Ephemeris for 12h. Berlin Mean Time.

1901.	R.A. h. m. s.	Decl. ° ′	Br.
May 16 ...	5 43 53 ...	+4 7·0 ...	0·07
20 ...	6 4 2 ...	5 20·0 ...	0·04
24 ...	6 20 18 ...	+6 21·2 ...	0·03

The comet is rapidly diminishing in brightness, and is following a north-easterly path through the northern part of Orion.

On the 16th it will be a short distance below Betelgeuse at sunset, and on the 24th near the Eye of Monoceros.

VARIABILITY OF EROS.—A telegram from Prof. E. C. Pickering, through the Centralstelle at Kiel, announces that on May 8 the variation in the light of the minor planet Eros was zero. The determination was made by Prof. O. C. Wendell.

WASHINGTON OBSERVATIONS, 1891–92.—The astronomical, magnetic and meteorological observations made at the United States Naval Observatory at Washington during the years 1891 and 1892 have recently been issued in one volume. After detailed descriptions of the instruments employed, the observations and reductions are given for each of the chief instruments, the transit circle, 26-inch equatorial, and 9·6-inch equatorial. The meteorological observations include those of pressure, temperature, wind, clouds, rain and snow.

An appendix is added containing the second Washington Catalogue of Stars, with the annual results upon which its compilation is based. The star places are all reduced to epoch 1875·0.

STELLAR PHOTOMETRY.—In *Comptes rendus* (vol. cxxxii. pp. 1091–1094) M. B. Baillaud, of the Toulouse Observatory, outlines a method he has recently developed for determining the magnitudes of stars from the measurement of photographs by means of a standard wedge photometer. Of course in this case the images are black on a luminous background, and the law governing the action of the wedge in the ordinary case of extinction of bright points on a dark background is not applicable here. Using a series of determinations on stars of known magnitude for the calibration and determination of constants, M. Baillaud develops the formula necessary for computing magnitudes by the method. On account of the spreading of the images of the brighter stars, producing definite sized discs, the method is less precise than for fainter objects, but it is hoped that much of the uncertainty in these cases may be removed by special expedients, and observations are in progress for fully testing the possibilities of the method.

NEW NEBULÆ.—M. G. Bigourdan gives, in *Comptes rendus* (vol. cxxxii. pp. 1094–1097), a list of fifteen new nebulæ observed by him with the west equatorial at the Paris Observatory (aperture 0·31 metre), during the period 1897–1900.

MUSK-OX AND BISON AT WOBURN ABBEY.

BY the kind favour of the Duchess of Bedford we are enabled to present our readers with a portrait of the young bull musk-ox now living at Woburn Abbey, in its present condition. The specimen is the survivor of a pair of yearling calves from Clavering Island, East Greenland, purchased by the Duke of Bedford in the autumn of 1899. They are believed to have been the first of their kind ever introduced into this country, and although one of the pair survived its arrival only for a very brief period, the other has continued to flourish and there is every hope that it will reach maturity. It is now considerably more than two years old, but although the horns are strongly curved they are still confined to the sides of the head and display no signs of growing on to the forehead, in the middle line of which their expanded bases should almost meet in the fully adult bull. At the time when the photograph was taken the animal was just beginning to shed its winter coat, the hair hanging in fleecy rags on the sides of the face. The great hump of hair on the withers forms a very noticeable feature in the general aspect of the animal.

The white patches on the face of the Woburn musk-ox forms the chief distinctive feature of the Greenland race of the species, which, it will be remembered, was named in this journal for December 13 last *Ovibos moschatus wardi*. It was at that time considered probable that the white-faced form of the musk-ox might be restricted to East Greenland; but specimens brought to the United States by Lieut. Peary from Grinnell Land and Ellesmere Land have enabled Dr. J. A. Allen, in a recent issue of the *Bulletin* of the American Museum of Natural History (vol. xiv. art. 7), to show that it has a much wider range, embracing apparently the whole of such parts of Greenland as are inhabited by these animals, together with the two countries above named. In addition to the difference in colour, Dr. Allen points out that the Greenland musk-ox differs from the typical *Ovibos moschatus* of Arctic America by the form of the horns and fore-hoofs. And he considers that it should be regarded as a species rather than a race; for this he takes the name *Ovibos wardi*, adding that if the Grinnell Land and Ellesmere Land animal should prove distinct it might be named after the intrepid

FIG. 1.—Young male Greenland Musk-ox at Woburn Abbey, photographed by the Duchess of Bedford.

American explorer by whom its skins were sent home. For our own part we see no reason to depart from the view that the Greenland and American musk-oxen are local races of one and the same species.

Another feature of special interest in the magnificent collection of animals at Woburn Abbey is the presence of representatives of both the European and American bison. It is now many years since these two splendid animals were seen side by side in the Zoological Gardens in the Regent's Park, and even then they were not shown in such favourable circumstances as are those at Woburn Abbey, which occupy adjacent paddocks of very large acreage. Of the American bison there is now a small herd, including a magnificent old bull as well as several calves, all of which are in splendid condition. When received, rather more than a year ago, the European bison, of which there were a bull and two cows, were very thin after their long journey from Lithuania; and one of the cows (whose skin is now mounted in the Museum of Science and Art at Edinburgh) did not long survive. The other cow and the bull have, however, greatly improved in condition during the last few months, and it is hoped that they may breed before long. The bull serves to show that, although in regard to its head and shoulders the American bison is the finer animal of the two, yet that its miserably weak hind-quarters render its whole appearance far inferior to that of its European cousin.

R. L.

RESEARCHES ON ORGANIC PEROXIDES.

In the latest number of the *Berichte*, v. Baeyer and Villiger have a number of interesting communications. The preparation of ethyl hydrogen peroxide, $C_2H_5O.OH$ is described. It is obtained by treating diethylsulphate with a solution of hydrogen peroxide in alkaline solution. The liquid is then acidified and distilled, when the new compound passes over between 90° and 100° mixed with alcohol and water. By further treatment a solution may be obtained boiling at 47–49° at 100 mm. and containing 80 per cent. of the peroxide. At the ordinary pressure it boils about 95°. It is soluble in water, alcohol and ether. It has a smell of both bleaching powder and acetaldehyde. A drop on the skin produces inflammation. It is relatively stable and may be kept for many weeks with very slight alteration. By superheating the vapour in a test-tube, a moderate detonation occurs. Dropped on finely divided silver it decomposes with a sharp explosion. It is a weak acid of about the strength of a phenol and gives salts with alkalis and alkaline earths. It is a strong oxidising agent. In studying the action of ethyl hydrogen peroxide with different reagents, the authors find that whereas nitrous acid yields nitric acid with hydrogen peroxide, alkyl nitrites do not give alkyl nitrates, but nitric acid and alcohol. On the other hand, ethyl hydrogen peroxide and nitrous acid or ethyl hydrogen peroxides and alkyl nitrites give in both cases the alkyl nitrate. These reactions are explained on the assumption that an additive compound is first formed from which either water or alcohol is subsequently removed. Moreover, where there is a choice between the removal of an "alkoxyl" or "hydroxyl" group, the latter takes precedence. This alone would not explain the behaviour of ethyl nitrite and hydrogen peroxide, on the one hand, and nitrous acid and ethyl hydrogen peroxide on the other, which should yield the same product, viz., ethyl nitrate.

$$O{:}N.OC_2H_5 + H_2O_2 = O{:}N(OH)_2OC_2H_5 = O_2N.OC_2H_5 + H_2O$$

$$O{:}N.OH + C_2H_5O.OH = O{:}N(OH)_2OC_2H_5 = O_2N.OC_2H_5 + H_2O.$$

But if the peroxides form additive compounds by separation into H and O_2H or $O_2C_2H_5$ ions, the apparently anomalous changes are readily explained.

$$O{:}N.OC_2H_5 + H_2O_2 = O{:}N\begin{array}{l} OC_2H_5 \\ H \\ O.OH \end{array}$$

$$O{:}N.OH + C_2H_5O.OH = O{:}N\begin{array}{l} OH \\ H \\ O.OC_2H_5 \end{array}$$

The nitrosoperoxide acid then by intramolecular rearrangement passes into nitric acid or its ester.

In the same journal, v. Baeyer and Villiger describe a hydrate of sulphurylchoride, $SO_2Cl_2 + 15H_2O$, which they prepare by pouring the acid chloride on ice. The hydrate has the appearance of camphor and remains undecomposed by ice-cold water for hours at a time.

The disputed question as to whether hydrogen peroxide and silver oxide, when brought into contact, yield the oxygen of the metallic oxide as well as an atom of oxygen of the peroxide, which is Thénard's view, or whether, according to Berthelot, the silver oxide acts as a catalysator by reducing the peroxide of hydrogen to water, is determined by v. Baeyer and Villiger in favour of Thénard.

IRON AND STEEL INSTITUTE.

The annual general meeting of the Iron and Steel Institute was held on May 8 and 9. Sir William Roberts-Austen, K.C.B., the retiring president, announced that Andrew Carnegie Research Scholarships, each of the value of 100*l*., had been awarded to Dr. A. Stansfield (London), to Dr. J. A. Mathews (New York) and to Mr. J. Goldberg (Leoben, Austria). Mr. Carnegie announced his intention of doubling his original donation for the purpose of founding these scholarships. Mr. William Whitwell was then inducted into the presidential chair. Having presented the Bessemer Gold Medal for 1901 to Mr. John Edward Stead, in recognition of the value of his investigations of the physical and chemical properties of iron and steel, the president delivered his inaugural address, in which he reviewed the scientific and industrial achievements of the past reign, and enumerated some of the most important problems in metallurgy that still await solution. A vote of thanks to the president for his admirable address was proposed by Mr. Carnegie and seconded by Sir Lowthian Bell.

The first paper read was by Mr. A. Greiner, of Seraing, Belgium, on dust in blast-furnace gases, in which he described the methods adopted to get rid of the dust in blast-furnace gases used as motive power for blowing-engines.

Mr. J. E. Stead then described some clearly defined idiomorphic crystals recently discovered in the hearth of a blast furnace at Blaina, Monmouthshire. They were found in a cavity of the sandstone foundation of a furnace, in which spiegeleisen and ferromanganese had been made. The crystals yielded on analysis: manganese, 51·75; iron, 35·76; silicon, 3·62; carbon, 3·71; oxygen, &c., 5·16. They belong to the orthorhombic system, and the results of measurements by Mr. H. Bauerman and by Mr. L. J. Spencer are given in the paper. The compound is described as a carbo-silicide of manganese and iron.

Mr. J. E. Stead and Mr. John Evans next read an important paper on the influence of copper on steel rails and plates. It is generally thought that copper has a very deleterious effect, and engineers, when buying steel, frequently specify that it must be absent. The authors clearly show, however, that the general opinion is erroneous. They prove that between 0·5 and 1·3 per cent. copper has no deleterious effect on either the hot or cold property of steel; that a very large amount (2 per cent.) makes the steel more liable to be over-heated; and that in small quantities it slightly raises the tenacity and the elastic limit, but, unlike phosphorus, does not sensibly make the steel liable to fracture under sudden shock. Like carbon, it reduces the power of the steel to extend under stress, but this is not pronounced when the quantity is small. The effect is more marked when large quantities are present. Lastly they prove that if the evidence of the open-hearth steel trial can be confirmed, copper, instead of producing redshortness, has the contrary effect of changing redshort steel into steel which will roll without cracking.

Mr. William Garrett, of Cleveland, Ohio, submitted a comparison between American and British rolling-mill practice. The paper was followed by an animated discussion, which was resumed on Thursday.

Mr. R. M. Daelen (Düsseldorf) described some recent developments of the use of hydraulic power in the manufacture of iron and steel.

Mr. Axel Sahlin discussed the economic significance of a high percentage of silicon in pig iron for the acid steel processes. The demand for high silicon in pig iron is, he considers, doing much to hamper progress in a certain branch of the British iron industry.

The paper by Prof. J. O. Arnold on the properties of steel castings embodied research work extending over six years. The lessons taught by the data set forth in the preliminary experiments detailed in this paper show that pure iron and carbon steel is not a suitable material for fulfilling the modern specifications drafted by engineers for steel castings. With iron and carbon castings the ductility demanded can be ensured with ease, but with such ductility it is impossible to correlate the required tenacity. The latter property, it is true, can be obtained from iron and carbon castings, but at the expense of an almost complete loss of ductility. Therefore, as has already been remarked, excepting the nearly pure iron the series of castings described have small manufacturing interests. Nevertheless they form the basis upon which the mechanical influence of silicon and manganese can alone be scientifically measured.

The remaining papers were taken as read. Among these the paper by Mr. Axel Wahlberg, of Stockholm, on Brinell's method of determining hardness and other properties of iron and steel was an elaborate memoir of great importance. The method consists in forcing, by means of pressure, a hardened steel ball into the material to be tested so as to cause an impression, the diameter of which is then to be measured, in order to obtain the spherical area of the concavity. The quotient resulting from dividing the maximum pressure by this area will then represent what is called by Brinell a *hardness number*, indicating, according to him, the amount of pressure (kilograms per square millimetre) to which the material so tested has been subjected. With this method a number of researches have been carried out, detailed particulars of which were given. They relate to the determination of hardness of various metals, to controlling forging tests, and to the hardening of iron and steel. Under the last head experiments were made to ascertain the influence of the percentage of carbon on the hardening capacity, the hardening effect of different quenching liquids, the influence of the temperature of the quenching liquid on the hardening result, the influence of different hardening temperatures. Other researches described dealt with an attempt to ascertain the homogeneity of iron and steel, the degree of annealing, the influence of cold-working, determination of the yield point, ultimate stress and elongation, and tests of blanks for gun barrels.

Prof. E. D. Campbell gave the results obtained at the University of Michigan during the past three years in investigating the heat of formation of the compounds of iron with carbon and silicon.

Mr. Axel Sahlin described a water-cooling device introduced by himself for protecting the walls of the lower part of the blast furnace.

Mr. J. M. While submitted a description of the new Bessemer shop and heating pits at the Barrow Hæmatite Steel Company's works. The results obtained are of interest as showing that the faster working in vogue in the United States cannot be introduced into England with advantage, for the same conditions do not apply in each country.

Mr. H. E. Wimperis, acting on a suggestion from Prof. Ewing, measured Young's modulus for a long rod by tension in an ordinary testing machine, and compared the value thus obtained with that found by experiments on pure bending. The two values differ slightly from each other, but such differences as are found may be regarded as indicating that there is no internal sliding due to layers of any impurity that may be contained in the metal.

Mr. Bennett H. Brough, the secretary, described a medal presented to the Institute by Mr. E. J. Ljungberg. It was struck in steel from the Domnarfvet Steelworks, Sweden, and is the first medal that has ever been struck in that metal. The soft basic Bessemer steel of which the medal is made contained: carbon, 0·05; manganese, 0·19; silicon, 0·007; phosphorus, 0·002; sulphur, 0·005.

Baron H. von Jüptner submitted a paper on iron and steel from the point of view of the phase-doctrine, in which he controverted some of the views elicited by the publication of the paper by Bakhuis-Roozeboom last autumn. He deals chiefly with the state of equilibrium between martensite and graphite.

The next meeting of the Institute will be held in Glasgow in September.

VITRIFIED QUARTZ.[1]

ALTHOUGH the great improvements introduced into the art of glass making by Abbe and Schott have led to marked advances in microscopy, in thermometry and in other departments during the last quarter of a century, glass is still unsuitable for many of the purposes to which we put it, and there remains a real need for some plastic material more infusible, more insoluble, more fully transparent, more elastic and more stable under changes of temperature than glass.

Such a substance exists in the form of vitrified quartz, or vitrified silica as I shall prefer to call it. Vitrified silica was first made in 1839 (*Comptes rendus*, viii. 678, 711) by M. Gaudin, who spun threads of it by hand and noticed their flexibility; and made small, very hard pellets of it by dropping fused quartz into cold water, and observed that in this form it was inactive to polarised light.[2] It was rediscovered in 1869 by M. Gautier (*Comptes rendus*, cxxx. 816), who made capillary tubes and spirals of vitreous silica and exhibited them at the Paris Exhibition in 1878, but who failed to obtain larger objects even with the aid of the electric furnace. Finally it was discovered yet once again, in 1889, by Prof. C. V. Boys, who used the torsion of "quartz fibres" for measuring small forces and produced fine tubes and small bulbs of the same material, and who was the first to fully recognise the great value of this remarkable substance.

As all who are here to-night are not chemists, I may remind you that quartz or rock crystal has for some time past been used by spectacle makers and in the construction of optical instruments; and that it is a form of oxide of silicon[1] which is very familiar to us all in the forms of sand and flint. Quartz is occasionally found in magnificent masses, but our chief source of supply is Brazil, where it occurs in large fragments like these before us on the table.

Quartz itself exhibits many of the desirable qualities enumerated above. It is hard, transparent to the ultra-violet rays, difficult to melt, a good insulator, and insoluble in most solvents, but it bears sudden changes of temperature very badly, and therefore it is not easy to manipulate quartz at high temperatures. When it has been vitrified by heat, however, it becomes much more tractable, and in the vitrified state (vitrified silica) it is not very difficult to deal with.

It is about this "vitrified silica," how to prepare it and fashion it into apparatus when plastic, and about its properties and uses that I am about to address you to-night.

The first obstacle met by those who wish to obtain vitrified silica is caused by the tendency of quartz to splinter. It will not bear contact with a flame. As you see, when a piece of quartz is thrust into a flame it cracks and falls to pieces, and the fragments again break up when similarly treated. Consequently, it was very difficult for the pioneer workers to soften their quartz in the flame. It is true that if the quartz be broken small and heated to redness in a crucible it becomes more easy to manage, but even then it gives trouble, and I should not like to say how much my first silica tube, which held about 5 c.c., had cost me for oxygen and labour when it was finished.

Fortunately we have found that we can prevent the splintering of quartz by heating it in small fragments to about 1000° C. and throwing it quickly into cold water. As you see, when this is done the quartz becomes white and enamel like, and after the treatment has been repeated the product, though still in masses, will not splinter to the slightest extent if it be thrust suddenly into the hottest part of an oxy-hydrogen flame. The preparation of this non-splintering silica constitutes the first stage of the process we are about to show you.

Another difficulty is connected with the oxy-gas burner. Vitrified silica only becomes sufficiently plastic for our purpose when it is above the melting point of platinum; and it cannot be heated sufficiently in all parts of an oxy-gas flame. What is wanted is not so much a very large flame as one which presents a very hot spot (this is situated just beyond the inner blue cone of the flame). After trying all sorts of burners I have concluded that the "mixed gas" jets give the best results, and of the burners I have tried the injector burner of Mr. Jackson, of Manchester, is decidedly the best I have met with.

The first step in the process of converting the white enamel like non-splintering silica into tubes and other vessels consists in pressing together the ends of two small fragments of the solid held in platinum forceps till they adhere, adding a third lump, then a fourth, and so on until a rough rod has been made. This rod is afterwards reheated and drawn out into finer rods about 1 mm. in diameter. In doing this care must be taken to heat each fresh mass of material slowly and from below upward in order that there may be as few bubbles as possible in the product.

A few of the fine rods of silica are next bound round a stout platinum wire, or twisted into a spiral while soft (Boys' and Dufour's method), and heated in the flame till their sides adhere. The uncouth tube thus produced is reheated, drawn out and closed at one end, a bulb is blown on the closed end in the usual manner, and this, when again drawn out, gives us a fine and fairly regular tube which can be lengthened by adding silica to one end of it, blowing a new bulb from this and drawing it out as before.

The enlargement of the small bulbs was rather difficult at first. My earliest attempts consisted in adding small lumps of silica to one end of a bulb, softening them in the flame and expanding the bulb by blowing. It is not impossible to succeed in this way, though the vessels so produced are apt to be uncouth in appearance. But the process is unsatisfactory owing to the fact that often the thinner parts of a bulb immediately surrounding the mass to be expanded become hotter and softer than the latter. When this happens the bulb bursts, and as it can only be repaired by the addition of fresh lumps of silica the process is apt to be tedious and expensive. After many failures, it occurred to me that I might develop the bulbs by applying thin rings of silica as shown in Fig. 1, heating them until the silica begins to spread

[1] A discourse delivered at the Royal Institution, on March 8, by W. A. Shenstone, F.R.S.

[2] A recent observation made by Prof. S. P. Thompson confirms this.

[1] Silicon was discovered by Berzelius in 1823.

and then expanding them by blowing. This method gave satisfactory results at once. By it we can produce long tubes and other apparatus like those exhibited to-night, if not at a very quick rate or very low cost, yet with certainty and very much more quickly than before.

When a tube of silica has been made it can be worked in the flame as easily, though not as inexpensively, as glass. Such a tube can be thickened readily by adding fresh rings of silica; it can be drawn out to various degrees of fineness and sealed hermetically; whilst all kinds of joints can be made easily. In one respect silica is easier to work than glass. It never breaks when thrust into the flame, and finished apparatus needs no annealing.

One precaution must be taken. The eyes must be protected by black spectacles. The glass of which these are made must

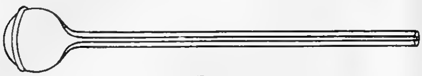


FIG. 1.

be very dark; so dark that white hot silica does not look very bright when viewed through it.

I have spoken of silica as being easy to work. I do not mean you to understand, however, that it is easy to do what you see Mr. Lacell doing to-night. It is not easy to perform any operation of this sort with his wonderful precision, and especially it is not easy to work under the conditions enforced upon him to-night, for he can see nothing of the effects he produces and must adapt his manipulations to my remarks although he can hear the latter only very imperfectly.

The Properties and Applications of Silica.

Vitrified quartz is harder than felspar, but less hard than chalcedony. When cut with a file it breaks like glass. Its conducting power for heat is about equal to that of glass. Mr. Boys has shown that, even in an atmosphere saturated with moisture, it is a very good insulator. Its density (2·21)[1] is decidedly less than that of quartz (2·66). Its optical properties have not yet been fully studied, but its approximate index of refraction has been determined by Prof. S. P. Thompson by means of a small prism cut for the purpose by Mr. Hilger. It is decidedly less than that of quartz.

The melting point of silica is not known and it is plastic over a considerable range of temperature. When a platinum wire embedded in a thick tube of silica is heated from without by means of an oxy-gas flame, the platinum melts and runs at a temperature at which the silica retains its shape.

Its rate of expansion has been studied first, by H. Le Chatelier (*Comptes rendus*, cxxx. 1703) and more recently by Prof. Callendar. The former finds its mean coefficient of expansion between 0° and 1000° to be 0·0000007, but from the manner in which his material was prepared I think it is probable that it was not quite pure. Prof. Callendar has, within the last few days, examined the behaviour of a rod of pure vitrified silica prepared by my method. He finds its mean coefficient of expansion to be only 0·00000059, which is only $\frac{1}{17}$ as great as that of platinum, and much smaller than that of any other similar substance that has hitherto been studied. He finds also that the expansion of vitrified silica is exceedingly regular up to 1000°, and that if not heated above 1000° the rod returns very exactly to its original length when cold. Beyond 1000° he found a slight permanent elongation, although the rod was under compression. Prof. Callendar was able to carry his experiments up to 1500°, which is very satisfactory, for it shows that vitrified silica remains solid, or practically solid, at this very high temperature. This is an important observation, as less carefully conducted experiments had led us to fear that it became slightly plastic even at as low a temperature as 1000°. Above 1000° the rate of expansion diminishes rapidly, changing to a contraction at about 1200°.[1] On cooling from 1500° to 1200° it expands.

Fine rods of silica and also quartz fibres are apt to become rather brittle after being heated to redness. But we have not at present detected this defect in the case of thick tubes or rods.

The transparency of vitrified silica to the ultra-violet rays has been carefully examined by Dr. A. Wynter Blyth, to whom I am greatly indebted.

The following figure (Fig. 2) illustrates very well the character of the results he has obtained. This figure gives the results of photographing electric sparks taken between electrodes made of an alloy of mercury, tin, zinc and cadmium after passing the light through sheets of quartz, vitrified silica, soda glass and flint glass. The plates of the last three substances were of equal thickness and were carefully prepared for me by Mr. Hilger.

The results show, as indeed we have found by actual experiment, that silica tubes are much more suitable than glass ones for use in studying the spectra of electric discharges.

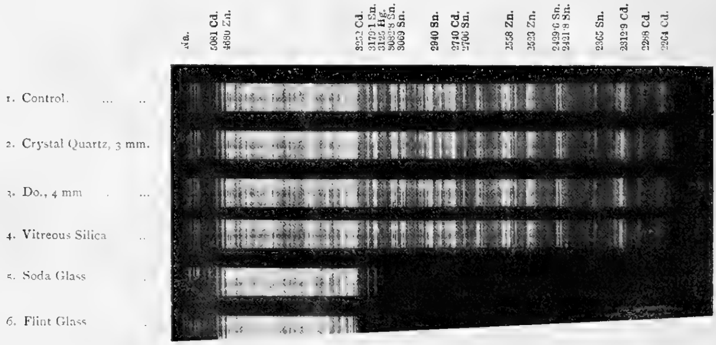


FIG. 2

The most remarkable property of vitreous silica is its behaviour under sudden changes of temperature. We have seen already that tubes of it may be plunged suddenly into an oxy-gas flame without injury, and I have mentioned the fact that apparatus made of silica needs no annealing. But this is not all; we may drop water on a white hot vitrified silica rod, or plunge white hot silica into cold water, or even, by Prof. Dewar's kind aid, into liquid air without injuring it in any way whatever; indeed, experiments seem to show that the material gains very distinctly in regard to its elasticity when it is thus treated. I need hardly point out how convenient tubes of such a material will be to

[1] This was determined by my pupil, Mr. T. Pears, the silica used contained a few minute bubbles.

[1] Le Chatelier's curve, see Fig. 3, shows a similar contraction, but commencing at a somewhat lower temperature.

chemists, or how many spoilt lecture experiments may be avoided in future by those who possess a silica tube.

This last property of silica and the splintering of quartz find an explanation in the results obtained by Le Chatelier (*Comptes rendus*, cviii. 1046, and cxxx. 1703) and by Callendar. These, as already explained (Fig. 3), show that its rate of expansion is exceedingly low, and, moreover, that at temperatures much above 1000° it contracts when heated. In these circumstances it follows, first, that the strains set up in silica when it is suddenly heated or cooled are comparatively small in amount, and, secondly, that if, for example, vitrified silica be suddenly cooled from 1500° to temperatures below 1000°, the strains set up at the earlier stages of the change must tend to neutralise those produced subsequently. These facts enabled Le Chatelier to predict, a little while ago, the indifference of vitrified silica to sudden change of temperature. But the phenomena had been observed previously and exhibited in this country.

The behaviour of quartz under changes of temperature is also peculiar. This was studied by Le Chatelier in 1889 (*Comptes rendus*, cviii. 1046). From his curves, which are given in Fig. 3, it may be seen that this form of silica expands quite regularly, and much more rapidly than vitreous silica up to 570°, but that at that temperature a sudden expansion takes place which is followed by a steady contraction on further heating.

One of the most important fields in which vitrified silica is likely to be useful is that of thermometry.

Owing to the small coefficient of expansion of vitrified silica the degrees of silica-mercury thermometers will be of greater length in proportion to the volumes of the bulbs than those of

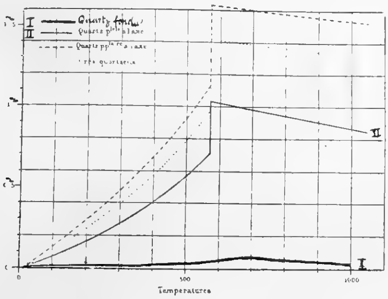


FIG. 3.

glass instruments. Owing to its high melting point it should be possible to employ it with advantage for measuring high temperatures by replacing the mercury by tin or some other metal, as has been done by M. Dufour (*Comptes rendus*, cxxx. 775). And whilst the great elasticity of vitrified silica suggests that the zero points of silica-mercury thermometers will be much more stable than those of glass instruments, the impunity with which it may be suddenly cooled from high temperatures promises obvious advantages.

Finally, the high melting point of silica should make it very valuable for use in platinum thermometers, and I exhibit such a thermometer to-night which has been fitted up for Dr. R. T. Glazebrook. But as the applications of vitreous silica to thermometry are still under investigation I will not dwell on this part of the subject except to add that, as glass reservoirs for air thermometers have proved disappointing, I am not without hopes that the new material may prove helpful in that department also.

We have not yet had time to examine the behaviour of silica with solvents, but if it acts like other forms of the same compound, it may be expected to replace platinum for some purposes, as, for example, for condensers for the preparation of pure water, and vessels of silica probably would be much more suitable for use in exact experiments on the freezing points and boiling points of many dilute solutions than the glass tubes now often used for such work. But, of course, silica vessels would be very susceptible to the action of alkalis. Finally, silica may be expected to prove superior to glass for use in researches on pure gases, owing to the qualities of its surface, and in experiments concerning the behaviour of gases at high temperatures. We have already one small application of silica to research in this latter field to put upon record. It is well known that nitrogen and oxygen enter into combination under the influence of the silent discharge, and Sir William Crookes (*Chem. News*, lxv. 301) has shown that oxides of nitrogen are present in considerable quantities in the flames which accompany the electric discharges of large induction coils; but although various observers have reported indications of the presence of nitrous fumes in the neighbourhood of flames, the forming of an oxide of nitrogen from oxygen and nitrogen alone, and without the intervention of electricity, has not, so far as I am aware, been unmistakably established. Therefore it is interesting to record the fact, first observed by Mr. Lacell, that nitric peroxide may be produced by heating a mixture of oxygen and nitrogen above the melting point of platinum in tubes of silica. It is easy to obtain a gas showing a distinctly yellow colour and exhibiting the reactions of nitric peroxide in this way.

Of course vitreous silica is not entirely without defects. Unfortunately it becomes slightly permeable to hydrogen, as platinum does, though to a less extent (Villard, *Comptes rendus*, cxxx. 1752), at about 1000°. It is attacked when hot by alkaline oxides. It may be heated to about 960° in contact with copper oxide without injury, but at higher temperatures it is attacked. It may be heated more strongly with ferric oxide, but quicklime attacks it at a bright red heat. It is evident that caution must be exercised when it is employed with basic oxides or alkaline solutions. When one first fashions vessels of silica before the flame the vessels exhibit to a greater or less extent a phenomenon resembling devitrification. They become covered with a white opaque crust. This is easily removed by reheating, provided that the tube has been kept scrupulously free from dust and dirt during the process of making it. If this be not done the appearance of the vessel may be spoilt permanently. The earlier observers attributed this phenomenon to the volatility of silica. My impression is that it is connected with the minute traces of alkaline metals present in most Brazil pebble which are usually burnt off in the processes I have described. From what I have told you to-night you will see that in several respects vitrified silica is as much superior to the best glass as Jena glass is superior to more ordinary specimens, and that the progress made in the last few years will make it possible for investigators to employ vitreous silica much more widely in the future than has been possible in the past. At the same time it is evident that the processes for producing vitreous silica are still in their infancy, that there is much more to be done and that further progress can only be made at considerable expense.

In concluding my remarks I wish to express the great obligation I am under to my friend Mr. Lacell. You will have discovered for yourselves that the chief burden has been upon his shoulders to-night, and that without the illumination provided by his precise and beautiful manipulation my discourse would have been but a dry affair. Also I must add that the cost of the work at its later stages has been aided by a subsidy from the Government Grant Fund of the Royal Society.

NOTES FROM RECENT CONSULAR REPORTS.

A REPORT on German East Africa, by Mr. A. C. Hollis, acting vice-consul at Dar-es-Salaam, and one on Veterinary Work in British East Africa and Uganda Protectorates, by Mr. R. J. Stordy, have recently been published as Nos. 2568 and 551 of the Foreign Office Series. The following notes from the reports refer to matters of scientific interest:—

GERMAN EAST AFRICA.

Locusts.—Great interest was shown in the success of the discoveries made at the Grahamstown Bacteriological Institute in the destruction of these insects, and a small quantity of "locust fungus" was imported, and has since been used on Kilima Njaro and in Usambara with success.

Caoutchouc.—There are numerous sorts of caoutchouc creepers and trees indigenous to German East Africa, but the only kinds which are of value are *Landolphia Kirkii* (Kiswahili, *Mohango*), and *Mascarenhasia elastica* (Kiswahili, *Mgora*). Until quite lately it was believed that the best rubber was the product of *Landolphia florida* var. *Comorensis* (Kiswahili, *Mbungo*), but it has now been proved that this creeper is practically worthless.

Samples of the milky juice of the wild fig tree have been sent to Europe on several occasions, but the price obtained has always been so low as not to repay the cost of transport.

Several trials have been made with other kinds of rubber. *Hevea Brasiliensis* (Para rubber) has been planted repeatedly, but without success, the climate being too dry. *Ficus elastica*, *L. Madagascariensis*, and an *Euphorbia sp.* (from Madagascar) have done fairly well. *Castilloa elastica*, *Hancornia speciosa*, and *Willoughbeia* were each tried once, but the seed did not germinate. *Manihot Glaziovii* (Ceara rubber) was first planted at Tanga in 1891. There are at present about 20,000 trees, but it is feared that it will not pay as the atmosphere is too moist. It is thought probable that Ceara rubber will do better in Donde-Barikiwa (Kilwa district), where a small experimental plantation has lately been opened.

Forestry.—The numerous rivulets and creeks, which form the mouths of the Rufiji River, and which cover an area of 100,000 acres, are lined by extensive mangrove swamps producing the timber known as *boriti*, or Zanzibar rafters. It is the opinion of various botanists that when traders—both European and native—are allowed to cut *boritis* at will, the mangroves in course of time die out, as large numbers of big trees are usually cleared from one spot, thus exposing the young plants to the direct rays of the sun, which is said to kill them. In consequence, the only trees now to be found in various parts of the Rufiji Delta are *Phoenix reclinata Osmunda sp.*, and *Barringtonia racemosa.*

In order to preserve and, if possible, to increase the present supply of *boritis*, a forest officer and three wood-rangers have been stationed in the Rufiji sub-district. The trees are felled under their supervision, and the timber is sold by the German Government.

The custom of systematically stripping a part of the bark from the mangroves, as sometimes practised in the East and West Indies, is not permitted, as it is held that such a course must be injurious to the trees. After the timber has been felled, the bark is stripped and sold.

The regulations issued for the preservation of the woods in the Usambara Hills have done much to prevent the needless felling of valuable timber. Oaks, firs and other European trees are now being planted under the auspices of the Woods and Forests Commission. Similar regulations will shortly be issued for other parts of the colony.

Roads.—Broad roads have been made all over the colony, and it is now possible to drive from Dar-es-Salaam to Lakes Victoria Nyanza and Tanganyika, from Tanga to Kilima Njaro, and from Kilwa and Lindi to Lake Nyasa.

Surveys.—A trigonometrical survey of East and West Usambara has been made, and a map of the former (Handei) is about to be printed. Much topographical work has also been done in various parts of the colony, notably in Uhehe (Hauptmann von Prittwitz), in Usagara (Dr. Stuhlmann), and between the Tanganyika and Nyasa Lakes (Dr. Kohlschütter).

A Commission for the delimitation of the boundary between the Independent State of the Congo and German East Africa left the coast for Lake Kivu in September last. On the completion of the survey of the western frontier, it is hoped that an Anglo-German Commission will be organised to delimit the boundary between the Uganda Protectorate and this colony. The frontier between the British East Africa Protectorate and German East Africa has now been finally settled. An interesting book on the geology of portions of German East Africa, by Dr. Bornhard, was published during the course of the year.

Valuable work is at present being done by Drs. Busse and Kandt. The former is making a study of all the plants indigenous to the country, whilst the latter is exploring the little-known regions between the Tanganyika and Victoria Nyanza Lakes. To him belongs the honour of having discovered the sources of the Kagera-Nile.

Dr. Maurer, after spending three years in German East Africa, has written a lengthy report on the result of his observations, which is being published by the Hamburg Marine Observatory. A successor to Dr. Maurer was appointed in October last. Meteorological observations are regularly taken at a number of places.

Museums.—A museum of products, plants and minerals was established at Dar-es-Salaam in 1899, and has since been increased in size. A collection of the lepidoptera and coleoptera of German East Africa is also being made. The ethnographical museum in Berlin has been greatly enriched by collections received from the colony.

British East Africa and Uganda Protectorates.

Tsetse Fly Disease (*Ngana*).—Mr. Stordy reports that the extent of the tsetse fly belt may be said to be from Mtoto Andei to Simba, a distance of, roughly, 90 miles. The fly is migratory in tendency, so that no well-defined line on the map can be drawn which could safely exclude the possibility of its presence. The fly, however, has never been located further inland than Muani (a halting station in the Kiu Hills on the old caravan route). When studying the causes which rendered the island of Mombasa uninhabitable for horses, Mr. Stordy ascertained that an organism, the morphology of which was identical with that found in animals suffering from tsetse fly disease, was found in donkeys which had been working for some time on the island. The disease has been practically eradicated by the advent of the Uganda Railway, with its excellent service of horse-boxes and fly-proof gauze windows.

Domestication of the Zebra.—Mr. Stordy urges the advisability of utilising for purposes of transport an animal which is naturally immuned against the ravages of the tsetse fly disease and horse sickness, such, for instance, as the zebra, of which there is an enormous number. He adds:—

"I am convinced that, should the Government enter upon a scheme for its domestication, it would prove one of great value, and that at no very distant date a supply of animals would be available, not only for African service, but also for army transport work at home or in India. The great difficulty so far has been the domestication of the adult animal. I have, however, to suggest the following plan for obtaining a possible way out of the difficulty: I would propose that a kraal be formed within a district where firearms are non-existent, as in the case of a preserve. The kraal would have two extending arms leading from the open country into it, and would be constructed large enough to hold a herd of, say, 50 adult animals. Several mounted Cape boys would be employed, whose duty, in the first instance, would be to accustom the zebras in the neighbourhood of the kraal to the sight of horses or mules. If my anticipations prove correct, the zebras will in the course of a few days follow the horses or mules, and advantage could be taken of this to lead them into the kraal. If it were, however, found that they would not be led it would be necessary to have them driven in by the Cape boys, assisted by swift-footed natives.

"The animals being in this way confined within the kraal they would naturally propagate their species. It is with the offspring that I would propose that the experiment in the way of domesticity would begin. As is well known, it has been found nearly impossible to rear a zebra foal apart from its mother. I would not propose to separate them, they would live along with and be nurtured by their mothers. A few months after birth the young animals could be caught and by various ways become accustomed to the sight and presence of man. I am very hopeful that in this way a number of young animals of both sexes would become domesticated and prove useful for transport service, and also in propagating their species. The second generation, if my experiment prove in any way successful, would be even more domesticated than their parents, and I am sure that in course of time a large supply of the domesticated zebra would be forthcoming for the future use of transport work at home and abroad. The initial cost might be a little more than the first results might justify, but there is no reason to doubt that in the long run the ultimate results would far more than compensate for the initial expenditure."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The John Lucas Walker Studentship in Pathology has been awarded to Mr. H. C. Haslam. Dr. E. S. Sladen, who has recently been serving in the Ashanti war, has been reinstated as a second student.

The board for moral science propose the assignment of certain rooms connected with the temporary pathological laboratory for practical work in experimental psychology, under the direction of Dr. Rivers.

A syndicate is to be appointed to consider the question of affording official recognition and support to the work now carried on by the Cambridge Appointments Association.

Mr. W. Bateson, F.R.S., of St. John's College, is to be re-appointed deputy for the professor of zoology and comparative anatomy during the ensuing academical year.

WE are glad to see that the London County Council has this year again arranged special beds of plants in Battersea, Ravenscourt and Victoria Parks, with a view to encourage the study of botany among pupils in elementary and secondary schools. At each of these parks about twenty beds are arranged near the paths, each bed containing specimens of a distinct order of plant, and each plant being labelled with its common name and its Latin name. In order to further assist the teaching and study of plants, arrangements have been made by which teachers may obtain orders from the Council's Technical Education Board which will enable them to secure specimens suitable for teaching purposes.

OUTDOOR work by students appears to be carried on in connection with several institutions on the other side of the Atlantic. We notice in *Science*, for instance, that the biological department of the University of California has just commenced a systematic biological survey of the coast of that state. Temporary headquarters are established at San Pedro, and the work during this summer will be carried south from Pt. Conception toward San Diego. A gasoline launch, which has been obtained for the season, will be fitted out with apparatus for dredging, sounding and making observations on temperature, salinity, specific gravity, &c. The work will be carried on by the members of the department and graduate students, together with a number of investigators who have already interested themselves especially in the west coast faunas. A party of students from Harvard University will undertake, this summer, an expedition to Venezuela for botanical and zoological research. We see also that the Mining School of McGill University will this year carry on its summer work in British Columbia. The class has just left Montreal to go out to the Pacific coast, visiting the various collieries along the line of the railway and on Vancouver Island. The party will then go into southern British Columbia for the purpose of studying the mineral deposits of the Slocan, Trail Creek and Boundary Districts, and, returning by the Crows' Nest Pass route, will visit the coal mines at Fernie Hethbridge, reaching Montreal again about the middle of June.

AT a meeting of the Court of Governors of University College, Liverpool, on Saturday last, the following resolution was passed:—"That, while gratefully acknowledging the advantages which have accrued to University College, Liverpool, by its association with the Victoria University, this Court is of opinion that a University should be established in the city of Liverpool, and will welcome a scheme with this object upon an adequate basis." In moving this resolution, Mr. Robert Gladstone, who presided, remarked that the success of the college showed the need for a University. The fees from students had increased from 700*l*. in its first year to 9500*l*. this year. Within the last few years 22,000,000*l*. sterling had been given by private individuals in the United States towards founding Universities and colleges. Was it not the duty of the wealthy people of this country to follow that excellent example? If they did not they could hardly complain if trade passed away and our prosperity diminished. We had already had a blow from German chemists. The great indigo industry in India, which had made the fortunes of many people and been a great source of trade, was threatened with extinction by chemical discoveries made in Germany. It was a misfortune they were not made in this country, as they might have been if we had been better provided with means of investigation. He hoped that the people of Liverpool who had been indifferent to the progress of the college would awake to a better state of mind, and that by their assistance they might succeed in putting Liverpool in as pre-eminent a place with regard to learning as she now enjoyed with reference to commerce.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 28.—"Further Observations on Nova Persei, No. 2." By Sir Norman Lockyer, K.C.B., F.R.S.

In continuation of previous papers, the observations of the Nova made at Kensington are brought to midnight of March 25. Since the last paper of March 7, estimates of the magnitude of the Nova have been made on ten evenings, visual observations of the spectrum on eight evenings, and photographs of the spectrum on four evenings.

Since March 5 the magnitude of the star has been gradually decreasing, but between the nights of the 24th and 25th the light of the Nova decreased very suddenly, dropping from 4·2 to 5·5 in twenty-four hours, and becoming only just visible as a naked-eye star.

The colour of the Nova has undergone some distinct changes since the observation on March 5 last, when it was shining with a clarety-red hue. On the 9th and 10th it was observed to be much redder, due probably to the great development of the red C line of hydrogen.

On the 23rd and 24th the star was noted as yellowish-red, while on the 25th (after the sudden drop in magnitude) it was very red, with, perhaps, a yellow tinge.

On March 6 the photographs were very similar to those obtained in the earlier stages, the only apparent difference being in the relative intensity of the bright hydrogen lines as opposed to those having other origins, most of which have been shown to be probably due to iron and calcium. The hydrogen lines have sensibly brightened, while the others have become much feebler.

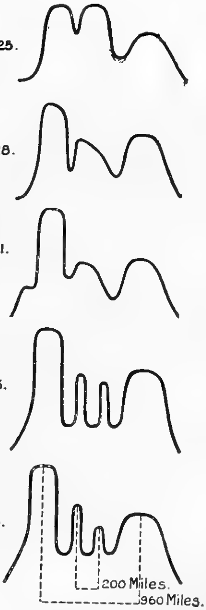


FIG. 1.—Light curve of Hβ (6-inch objective prism).

The photograph of March 10 shows a further dimming of the bright lines other than those of hydrogen.

On March 25, when the next good photograph was taken, the spectrum had undergone great modifications. The hydrogen lines are still very bright, though they do not show the structure which they did in the photographs taken between February 25 and March 10. The bright lines other than those of hydrogen, which are seen in the earlier photographs, have now disappeared, and other lines become visible. The continuous spectrum has also greatly diminished.

Approximate determinations of the wave-length of these new lines have been made by Mr. Baxandall by comparison with lines of known wave-length in the spectra of α and ε Persei photographed with the same instrument.

The lines at λ 3870 and 4650 are perhaps identical with those observed by von Gothard[1] in the spectrum of Nova Aurigæ

[1] *Ast. Phys. Jour.*, vol. xii., 1893, p. 51.

after it had become nebular, but associated with these lines in his record is the chief nebular line at 5007, no trace of which is yet visible in the photographs of the spectrum of Nova Persei. On the other hand, Hβ, which is the brightest line in the present spectrum of Nova Persei, does not appear at all in von Gothard's spectrum of Nova Aurigæ.

In the former paper the structure of the broad bright lines of hydrogen was referred to. A more detailed examination of the lines as photographed on several evenings shows that this structure has been undergoing changes.

The annexed figure (Fig. 1) gives light curves showing the variation in the loci of intensity of the line Hβ, as photographed with the 6-inch prismatic camera. These curves were plotted by Messrs. Baxandall and Shaw independently of each other, and I have satisfied myself of their accuracy. It will be seen that on February 25 there were three points of maximum luminosity, the two maxima on the blue side being of equal intensity, and greater than the third on the red side. By March 1 the centre one had greatly been reduced in intensity, and on the 3rd it had been broken up into two portions, thus making four distinct maxima.

Rough measures made on the relative positions of these points of maxima show that the difference of velocity indicated between the two external maxima is nearly 1000 miles per second, while that between the two inner maxima is 200 per second. We thus have indications of possible rotations or spiral movements of two distinct sets of particles travelling with velocities of 500 and 100 miles per second.

A similar examination of the F and G lines of hydrogen in the photographs obtained with the 30-inch reflector has also been made by Dr. Lockyer. In this longer series the most important point comes out that the maximum intensity changes from the more to the less refrangible side of the bright hydrogen line

"On the Electrical Conductivity of Air and Salt Vapours." By Harold A. Wilson, D.Sc., M.Sc., B.A., Allen Scholar, Cavendish Laboratory, Cambridge.

The experiments described in this paper were undertaken with the object of obtaining information on the variation of the conductivity of air and of salt vapours with change of temperature, and on the maximum current which a definite amount of salt in the form of vapour can carry. They are a continuation of the two researches on the same subject published in the *Phil. Trans.* for 1899.

The method employed in the experiments described in the present paper was the following :—

A current of air containing a small amount of a salt solution in suspension in the form of spray was passed through a platinum tube heated in a gas furnace; this tube served as an electrode, and the other was fixed along its axis. The temperature of the tube was measured by means of a platinum platinum-rhodium thermo-couple, and the amount of salt passing through the tube was estimated by collecting the spray in a glass-wool plug.

The variation of the current at constant E.M.F. with the temperature for air was found to be approximately capable of being represented by a formula of the type $C = A\theta^n$, where C is the current, θ the absolute temperature, and A and n constants. The constant n depends on the E.M.F. used. With 240 volts it was 17, and with 40 volts 13. The current, therefore, does not begin suddenly when the temperature is raised, but always increases regularly with the temperature, so that the lowest temperature at which the current can be detected depends entirely on the sensitiveness of the galvanometer.

The relation between the current and temperature for salt vapours was found to be rather complicated. With KI, using an E.M.F. of 800 volts, the current had the following values ($1 = 10^{-4}$ amperes).

Temp.	500°	600°	700°	800°	900°	1000°	1100°	1150°	1200°	1300°
Current	0·7	1·8	3·0	4·0	4·5	4·0	3.5	3·6	7·0	7·0

Thus the current has a maximum value near 900° C., and rises very rapidly near 1150°. Similar results were obtained with other salts.

The maximum current carried by the salt vapour (at 1300° with 800° volts) was found to be nearly equal to that required to electrolyse the same amount of salt in a solution. This fact must be regarded as considerable evidence in favour of the view that the ions are of the same nature in the two cases.

Linnean Society, April 18.—Prof. S. H. Vines, F.R.S., president, in the chair.—Mr. Harting exhibited and made remarks upon a mummified hawk from an Egyptian tomb, pointing out the difference between mummies made at Memphis, which are black, dry and brittle, from the bitumen employed in the embalming process, and those from Thebes, which, like the specimen exhibited, are of a yellowish colour, more flexible, and were prepared with natron, or neutral carbonate of sodium, Na_2CO_3, brought from the natron lakes in the Lybian desert. Colonel Swinhoe confirmed the statement that our word "mummy," Fr. *momie*, Sp. *momia*, was derived from the Arabic *moum*, wax, the most expensive process of embalming known to the Egyptians being that in which wax and bitumen were the chief ingredients.—Mr. Charles Dawson exhibited a hollow flint nodule which had been picked up on the downs at Lewes, and which on fracture was found to contain the desiccated body of a toad. The flint measured 5½ inches in length and 12 inches in circumference, and a small hole at one end indicated the point of ingress for the toad, which must have entered in a very immature condition, and died there after having attained a size too great to permit of its escape. In the discussion which followed, remarks were made by Mr. E. T. Newton, F.R.S., Mr. John Lewis, and others, the general opinion being that a modern toad had crept into an ancient flint, and, having lived for a time on such insects as found their way into the cavity, had died there.—Mr. S. Pace exhibited specimens of *Moseleya latistellata*, Quelch, the so-called "rugose coral" from Torres Strait. The specimens shown were obtained from the backs of pearl-shells collected in Friday Island passage at a depth of three to four fathoms. In the opinion of Mr. Pace they showed that the so-called coral was really a species of *Lithophyllia*.—Mr. W. B. Hemsley, F.R.S., exhibited the leaves and flowers of two new genera of Chinese trees: (1) Bretschneideria, discovered by Dr. Henry in the province of Yunnan, lat. 23° N., in forests at an elevation of 5000 feet, and bearing pink and white flowers like the horse chestnut, to which it is related; and (2) Itoa, also a native of Yunnan, growing at a similar elevation and to a height of about twenty feet. The genus, named in honour of a famous Japanese botanist, was stated to be allied to Idesia, Maxim., Poliothyrsus, Oliver, and Carrierea, Franch., all monotypic genera inhabiting China, but differing from them in certain respects which Mr. Hemsley indicated.—Mr. S. Pace read a paper on the formation and variation of the remarkable cup-shaped corallum of Turbinaria, on which no observations appeared to have been recorded. This was supplemented by a letter from Mr. H. M. Bernard, in which he offered some critical remarks on the paper which the author had previously submitted to him. Further observations on the bearing of the facts described were made by Prof. Howes.—Messrs. W. B. Hemsley, F.R.S., and H. H. Pearson communicated a paper on the flora of Tibet, based on various collections of high-level plants received at the Kew Herbarium. The country dealt with was described as lying between 80° and 102° lat. and 28° and 29° long., and having an average altitude of 15,000 feet. Within this area 360 species of vascular plants had been collected, and were referred to 144 genera and 46 natural orders. Almost all the orders represented were nearly of world-wide distribution, and none were really local. Of the 360 species only 30 appeared to be peculiar to Tibet. In illustration of the paper a selection of the plants was exhibited; most of them dwarf deep-rooted herbs, very few annual or monocarpic, and the only woody plant, *Ephedra gerardiana*, was described as scarcely rising above the surface of the ground. The majority had been collected at altitudes varying between 15,000 and 18,000 feet. Mr. C. B. Clarke, F.R.S., in making some observations on the paper, pointed out that the name "Thibet" or "Tibet" was quite unknown to the people who dwelt in the country so-called, and its precise boundaries were even still imperfectly defined. It was convenient, however, to retain a name by which it was known to so many European travellers, and the explorations and collections were making us better acquainted with the country every day.

Zoological Society, May 7.—Prof. G. B. Howes, F.R.S., vice-president, in the chair.—Mr. Sclater exhibited and made remarks on an original water-colour drawing by Sir Harry Johnston, K.C.B., of the remarkable new Mammal from the Semliki Forest in Uganda, which had been described (from fragments of skin only) under the name *Equus johnstoni*, and announced that the complete skin and two skulls from which it had been prepared were now on their way home. There could be no doubt that the animal was not an Equus, and could not be placed satisfactorily in any known genus of recent Mammals.—Dr. W. G. Ridewood exhibited and made remarks on a series of microscopic preparations of the hairs of Antelopes, Giraffe, Zebra, and the so-called *Equus johnstoni*, pointing out that the hairs of the last-named animal were similar to those of the Giraffe as well as those of the Zebra, but different from those of the Antelopes.—Mr. R. I. Pocock communicated a paper, by Mr. G. W. Peckham and Mrs. E. G. Peckham, on the spiders of the family Attidæ found in Jamaica, West Indies. It contained descriptions of thirteen new species, of which one was made the type of a new genus—Nilakantha.—Dr. David Sharp, F.R.S., communicated a paper by Mr. Peter Cameron, containing an account of the Hymenoptera collected during the "Skeat Expedition" to the Malay Peninsula. Fifty-four species were enumerated in the paper, of which thirty-one were described as new.—Dr. David Sharp also communicated a paper by Mons. Eugène Simon on the Arachnida collected during the "Skeat Expedition." It consisted of a list of the 131 species represented in the collection and descriptions of forty-eight new species and four new subspecies.

Royal Astronomical Society, May 10.—Mr. Hinks exhibited and described a new machine for measuring celestial photographs, made for the Cambridge Observatory under his superintendence, in the construction of which several improvements had been effected.—Dr. Lockyer showed slides from photographs of Nova Persei, and curves exhibiting its changes of magnitude.—Father Sidgreaves gave further results of the Stonyhurst observations of the spectrum of the Nova, which distinctly varied with the variations of its light.—Father Cortie read a paper on its visual spectrum, showing that the D lines came out strongly at a minimum, and that the spectrum resembled that of the solar chromosphere.—Prof. Turner communicated Mr. Bellamy's observations of the magnitude of the Nova and the neighbouring stars.—Mr. Wickham read the observations for magnitude made at the Radcliffe Observatory, Oxford, which supplemented and confirmed the observations made at South Kensington.—A curve made by Mr. Child was shown, exhibiting the variations in the brightness of the new star from the time of its discovery.—Observations of magnitude by Mr. Sharp and Mr. Stanley Williams were also read.—Father Sidgreaves suggested an explanation of the fact that the displacement of the lines in the spectra of new stars always indicated a rapid motion of approach.—Prof. Turner read a paper by Mr. H. C. Plummer on the geometry of the siderostat.—A paper by Mr. Franklin Adams was read on an observation of the "green flash" at sunset, a phenomenon which he considered similar to that of "Baily's beads" seen during a total solar eclipse.—Mr. Crommelin gave approximate elements of the orbit of the new comet, from which it appeared that it is moving rapidly from the sun and more slowly from the earth, and that its brightness is rapidly diminishing. Although it should shortly be visible in the evening sky it is improbable that it will be a conspicuous object.

DUBLIN.

Royal Irish Academy, May 13.—Prof. R. Atkinson, president, in the chair.—Hipparchus and the precession of the equinoxes, by Rev. M. H. Close. Hipparchus discovered the increase of the longitudes of the fixed stars, which produces the precession of the equinoxes, as we term it. That increase might be due to (*a*) the eastward progression of the stars; or to (*b*) the westward retrogression of the equinoctial points, from one of which the longitudes are reckoned; or to (*c*) both these movements existing together. We may dismiss *c* at once. Did Hipparchus believe in *a* or in *b*? Laplace, Lalande, and many others declare that he believed in *a*; Delambre, Bailly, and many others that he believed in *b*. None give any arguments for their opinions. Which are right? The former, as would appear thus: (1) Hipparchus admittedly shared the general belief of his times in the immobility of the earth. He had therefore a predisposition against *b*, which involves a movement of the earth. (2) Ptolemy's treatment in the *Almagest* of certain apparently (only) inconsistent expressions of Hipparchus on the present subject shows that he (Ptolemy), who ought to know, held that Hipparchus believed in the progression of the stars. Besides which, we have, in two places in the same work, Ptolemy's direct statement to the same effect. (3) At first, when Hipparchus had examined only certain zodiacal stars, and had observed their apparent progression, he supposed that the extra-zodiacal stars did not participate therein. But he could not have supposed this had he believed in the retrogression of the equinoctial points, for that would give an apparent progression to all the stars. He found afterwards, however, that the stars outside the zodiac preserved their positions relatively to those within, which, from his above-mentioned predisposition, would mean for him that all the stars progressed together.

PARIS.

Academy of Sciences, May 6.—M. Fouqué in the chair.—The influence of feeding, temperature, work and dust upon the evolution of tuberculosis, by MM. Lannelongue, Achard and Gaillard. A series of guinea-pigs, artificially infected with tuberculosis, were submitted to varying external conditions. If compelled to do a certain amount of mechanical work each day, the mortality increased with the amount of work done, those remaining at rest showing the most survivors. With insufficient food the effects were equally marked, those on full rations having the best chance of survival. The inhalation of dust had the same prejudicial effect as in man.—On the fourth volume of the *Annales de l'Observatoire de Toulouse*, by M. Lœwy.—M. Zeuner was elected a correspondant for the section of mechanics, and M. Oudemans a correspondant for the section of geography and navigation in the place of the late M. de Serpa Pinto.—The last sign of life; its application to man, by Dr. A. D. Waller. A modification of the method previously described, but in which the skin remains intact.—The thermal variations of waters, by M. F. A. Forel. The amplitude of the annual thermal variation is a function of the latitude. The depth of penetration of the heat is also a direct function of the latitude, amounting to about 100 metres for the Lake of Geneva, more than 150 metres for Loch Katrine, and more than 200 metres for Lakes Mjösen and Ladoga.—Application of the wedge photometer to the measurement of the photographic magnitudes of the stars, by M. B. Baillaud. The method would appear to give the most trustworthy results with stars of higher magnitudes, the measurements with the more brilliant stars not being so satisfactory.—Some new nebulæ discovered at the Observatory of Paris, by M. G. Bigourdan. A list of new nebulæ, mostly fainter than thirteenth magnitude, together with rectifications of the positions of some nebulæ previously described.—On a particular class of ruled surfaces, by M. A. Demoulin.—On the continuous deformation of surfaces, by M. G. Tzitzeica.—On Taylor's series, by M. L. Desaint.—A practical method for the correction of the secondary error of chronometers, by M. Ch. Ed. Guillaume. An application of the properties of nickel steel to the more perfect temperature compensation of chronometers.—On the existence of open currents, by M. V. Crémieu. As a consequence of the proof previously given that electric convection produces no magnetic effect, it follows that open currents ought to exist. Experiments are now described verifying the existence of these.—On osmosis through a membrane of copper ferrocyanide, by M. G. Flusin. An experimental determination of the relation between the osmotic pressure and the speed of osmosis. For solutions of saccharose, amygdalin and antipyrine the observed pressures agree satisfactorily with those calculated theoretically, none of the substance passing through the membrane. With a 1 per cent. solution of urea the observed pressure was far lower than that calculated, and in this case it was found that urea had passed through the membrane. The velocity of osmosis depends upon the thickness of the membrane, but for a given porous pot the velocities are proportional to the osmotic pressures, and hence inversely proportional to the molecular weights.—On the aluminium alloys. Combinations of aluminium with tungsten, by M. Léon Guillet. By the reduction of tungstic anhydride with an excess of aluminium a tungstide of aluminium can be isolated in the crystalline state, possessing the formula AlW_2.—On an iodoantimonide of mercury, by M. Albert Granger.—On a specimen of crystallised lime, by M. Ad. Jouve. In the preparation of calcium carbide, if the mass be cooled at the moment that the carbide commences to form, transparent prismatic needles of lime are obtained.—On the chemistry of methylene, by M. V. Thomas.—On the hydration of amylpropiolic acid with the formation of caproylacetic acid, by MM. Ch. Moureu and R. Delange. Amylpropiolic acid cannot be hydrolysed by sulphuric acid, but the reaction can be effected by boiling with caustic alkalis the β-ketonic acid, caproylacetic acid being formed.—On dimethyl-pyruvic acid, by M. A. Wahl. Of the various methods attempted to prove the constitution of this acid, the only one meeting with success was the reduction to α-oxy-isovalerianic acid by sodium amalgam.—On the anhydride of the supposed binaphthylene-glycol, by M. R. Fosse.—Action of the acid chlorides upon the ether oxides in the presence of chloride of zinc, by M. Marcel Descudé. In presence of anhydrous zinc chloride acetyl chloride reacts violently upon ordinary ether, giving ethyl acetate and ethyl chloride.—On the migration of the ternary materials in annual plants, by M. G. André. On the evolution of immature eggs of *Rana fusca*, by M. E. Bataillon.—On the development of the sole in the laboratory of Concarneau, by MM. Fabre-Domergue and Eugène Biétrix. The authors have been successful in developing soles from the eggs in an aquarium, with a mortality of only 50 per cent. They consider that their results open up the possibility of a culture of the sole commercially.—Chlorophyllian assimilation realised outside the living organism, by M. Jean Friedel.—On the movements of the soil and the formation of the valleys in Walachia, by M. E. de Martonne.—On the law of the electrical stimulation of nerves, by M. Georges Weiss. For an electrical stimulation of the nerve lasting t seconds, it is necessary and sufficient that it puts into play a quantity of electricity given by the formula $Q=a+bt$, a and b being two coefficients depending on the nerve and the distance of the electrodes. This includes the empirical formula of Hoorweg.—Researches on the injection of blood and of nephrotoxic serum in the dog, by M. Bierry.—Researches on the diseases of dogs. Vaccination of the dog against experimental infection, by M. C. Phisalix.—General characters of the teratogenous process, by M. Etienne Rabaud.—On the atmospheric dust observed at Tunis on March 10, by M. E. Bertainchand. An analysis of the red rain showed that it was essentially siliceous in character, containing only 6 per cent. of organic matter.—The movement in each synodic day of the instantaneous axis of symmetry of the barometric deviations, by M. A. Poincaré.

St. Louis.

Academy of Science, April 1.—Mr. John S. Thurman delivered an address on the many industrial uses now made of compressed air, illustrating his remarks by apparatus in operation, including electric motor air compressor, compressed air auger, drill, disinfecting atomizer, sculptors' and stone-cutters' tools, carpet renovators, &c., and a set of lantern slides showing the practical uses made of these and other implements and machines operated by means of compressed air.—Dr. Theodore Kodis exhibited, under the microscope, slides illustrating a new method of staining brain tissue, whereby, in four or five days, it has proved possible to prepare single or double stained preparations containing nerve cells with the dendrides of the latter brought out by a direct stain, instead of being differentiated merely as amorphous silhouettes, as is the case with the much slower Golgi process commonly employed. It was stated that the material is treated before sectioning, for about twenty-four hours, with cyanide of mercury, followed for approximately the same length of time by a formaldehyde solution, after which sections are cut, stained with phospho-molybdate hæmatoxylin and, if desired, a contrasting stain, such as one of the aniline greens, and mounted in the usual way.

DIARY OF SOCIETIES.

THURSDAY, May 16.

Chemical Society, at 8.—The Nutrition of Yeast, Part III.: Dr. A. L. Stern.—Derivatives of Methylfurfural: H. J. H. Fenton and Miss Mildred Gostling.—The Preparation and Optical Inversion of Optically Active Nitrogen Compounds, dextro- and Lævo-α-benzylphenyl-allyl-methylammonium Salts: W. J. Pope and A. W. Harvey.

FRIDAY, May 17.

Royal Institution, at 9.—Turkish Kurdistan: Earl Percy.
Society of Arts, at 8.—Polyphase Electric Working: A. C. Eborall.
Epidemiological Society, at 8.30.—What is Plague: Dr. Klein, F.R.S.

SATURDAY, May 18.

Royal Institution, at 3.—Rise of Civilisation in Egypt: Prof. W. M. Flinders Petrie.

MONDAY, May 20.

Royal Geographical Society.—Anniversary Meeting.
Victoria Institute, at 4.30.

TUESDAY, May 21.

Royal Institution, at 3.—Cellular Physiology: Dr. A. Macfadyen.
Zoological Society, at 8.30.—On the more noticeable mammals obtained by Sir Harry Johnston, K.C.B., during his Recent Expedition to Mount Ruwenzori: Oldfield Thomas.—On some Arctic Nemerteans: R. C. Punnett.—On the Anatomy of *Cogia breviceps*: Prof. W. B. Benham.
Society of Arts, at 8.—The Rise and Development of Egyptian Art: Prof. W. M. Flinders Petrie.
Royal Statistical Society, at 5.—Calculation of National Resources: V. V. Branford.

WEDNESDAY, May 22.

Geological Society, at 8.—On the Skull of a Chiru-like Antelope from the Ossiferous Deposits of Hunder, Tibet: R. Lydekker, F.R.S.—On the Occurrence of Silurian (?) Rocks in Forfarshire and Kincardineshire along the Eastern Border of the Highlands: George Barrow.—The Crush-Conglomerates of Argyllshire: J. B. Hill.
Society of Arts, at 8.—Testing and Training Distant Vision: R. Brudenell Carter.

THURSDAY, May 23.

Royal Society, at 4.30.—*Probable papers*: On the Presence of a Glycolytic Enzyme in Muscle: Sir Lauder Brunton and Herbert Rhodes.—On Negative After-Images and their Relation to certain other Visual Phenomena: S. Bidwell, F.R.S.—The Solar Activity, 1833–1900: Dr. W. J. S. Lockyer.—A Comparative Crystallographical Study of the Double Selenates of the Series $R_2M(SeO_4)_2, 6H_2O$.—Salts in which M is Magnesium: A. E. Tutton, F.R.S.—On the Intimate Structure of Crystals. Part V. Cubic Crystals with Octahedral Cleavage: Prof. W. J. Sollas, F.R.S.
Royal Institution, at 3.—The Chemistry of Carbon: Prof. J. Dewar, F.R.S.
Institution of Electrical Engineers, at 8.—Annual General Meeting.

FRIDAY, May 24.

Royal Institution, at 9.—The Aims of the National Physical Laboratory: Dr. R. T. Glazebrook, F.R.S.

SATURDAY, May 25.

Royal Institution, at 3.—The Rise of Civilisation in Egypt: Prof. W. M. Flinders Petrie.

CONTENTS.

THURSDAY, MAY 23, 1901.

NATIVE RACES AS IMPERIAL PROBLEMS.

The Natives of South Africa; Their Economic and Social Condition. Edited by the South African Native Races Committee. Pp. xv+360. (London: John Murray, 1901.) Price 12*s.* net.

BY far the most serious of all the questions confronting us in South Africa is the question of the native races. The reason is not far to seek. Two at least of the African races are endowed with extraordinary vitality. The Australian aborigines are a people which will neither thrive in the presence of the white man nor be absorbed into his hosts. They are, therefore, bound to die out in the presence of civilisation, and, however much we may regret it from philanthropic or scientific motives, the political and social problems involved will sooner or later cease to exist. It is otherwise with the Negroes and the Bantu. These two prolific races show no signs of decay when brought in contact with civilisation. On the contrary, their intestine wars and savage practices being put an end to, they increase rapidly in number.

The Negro is not found in South Africa. There the bulk of the native population is Bantu. The remains of the earlier peoples, Vaalpens, Bushmen and Hottentots, are (save the last named) of no political importance. They are, indeed, of considerable scientific interest. The Vaalpens, a black pigmy race dwelling in caves and holes in the Northern Transvaal and the Bechuanaland Protectorate, have never yet been subjected to scientific investigation. They are said to practice cannibalism, and to be the true aborigines. The Bushmen, of larger, though for the most part still diminutive, stature, are, like them, savages of a low type. They display, it is true, some advance on the Vaalpens, and are specially noted for their extraordinary skill in drawing. They are of a yellowish-brown colour. In this and some other physical characteristics they resemble the Hottentots, who, it has been conjectured, are the result of a mixture in blood of the earliest Bantu immigrants with the Bushmen. For the most part the Hottentots have come under the influence of civilisation, though there are communities of them still practising their own customs. The Bushmen are hunters. They have hardly yet taken the first step towards civilisation, in the shape either of agriculture or of herdsmanship. The Hottentots, on the other hand, are a pastoral people, while the Bantu in all their branches both keep cattle and are acquainted with rudimentary agriculture.

The Bantu are divided by Prof. Keane into three groups. The first consists of the Zulus and the tribes connected with them, such as the Ama-Xosa, the Matabele and the Kafirs. The second consists of the principal inhabitants of the Orange River Colony, the Transvaal, Basutoland and Bechuanaland, namely, the Basuto and Bechuana. The third includes the Amatonga, the Swazis, the Fingoes, the Mashona, Makalaka and other tribes, representing, according to Prof. Keane, "the first wave of Bantu immigration." This of course assumes that the Hottentots are not to be credited with Bantu blood, but are an offshoot of some other African stock.

In consequence of their overwhelming political and social importance, the work before us, though bearing a wider title, relates almost entirely to the Bantu. It is in substance a plea for a full official inquiry into the circumstances of the native races, with a view to framing a sound policy in dealing with them. We are first presented with a short account of the various peoples which, though taken from the best sources, shows very clearly how defective our knowledge is. In this account an estimate of the populations and a general outline of native laws and customs are included. We are next told on what terms we hold the different provinces of British South Africa. This is important, because our titles to all the provinces are not the same. The most extreme advocate of the right of the white man to the lordship of the world would probably admit there was a distinction to be drawn between cases in which we hold by right of conquest, either directly from the natives themselves or from those who had conquered them, and cases in which we simply administer the country by invitation of the natives. In the latter it is evident that every principle of justice requires us to treat the land as still their property and, regarding them as the true owners of the country, to administer it for their benefit.

These preliminary matters, necessary for the understanding, or at least for the setting in proper perspective, of what follows, having been disposed of, we approach the main subject of the book—the relations of the native population to their white rulers and to the white colonists in general. They are considered under the heads of (1) land tenure; (2) labour supply, occupations and wages; (3) the law of master and servant; (4) the compound system; (5) savings banks and labour agencies; (6) the pass laws; (7) education; (8) taxation; (9) franchise; and (10) the sale and supply of intoxicating liquors. It is not my intention to follow the writers in their review of these matters. Deeply interesting as they are, their interest is rather political and philanthropic than scientific, and so far it is foreign to this journal. It must suffice here to say that these chapters have been compiled with care from information supplied largely at first hand by correspondents (of whom a list is given) and by official and other documents; they are marked by sanity and moderation, and are written with the object, not of dogmatising on questions bristling with difficulty, but of collecting and presenting information.

The importance as well as the difficulty of the problems involved is evident. The total native population is estimated by the editors at about five times the numerical strength of that of the whites, and it is rapidly increasing. The natives are not allowed to indulge as they once did in intertribal wars, which would not only give them occupation but keep down their numbers. They are not at present fit for continuous labour. The habit of work is a growth of civilisation, and cannot be imposed as you put a coat of paint on a door. Generations are required to raise a people from savagery. It is no wonder, therefore, that the increase of their numbers and their idleness are sources of anxiety to the intrusive colonists. Various expedients have been tried. The Boer policy was first massacre, then slavery, cruelty and oppression. Nor have our own people always been guiltless in this respect. The results have been lamentable alike to the natives and to the Europeans. With the abolition of slavery a more humane policy on the part of the Government was inaugurated. But neither the Home Government nor the Colonial Governments have been invariably wise or consistent. Though on the whole their efforts have been honestly directed to the benefit of the natives, the conflicting interests of natives and colonists have often caused, and still cause, grave difficulties. The experiment has been made in Cape Colony and, to a more limited extent, in Natal, where the native question is more acute, of admitting natives who fulfil certain stringent conditions to the franchise. The numbers admitted are not yet large, but it is obvious that the principle thus introduced may involve consequences which cannot at present be foreseen.

Accordingly, the editors are abundantly justified in their belief that the time is opportune to consider our policy towards the native races throughout British South Africa. The information elicited by their inquiries is not exhaustive; it is only preliminary. One of the chief results has been the discovery how little we know about the natives and their needs. This is a point which the editors press again and again. In August last they presented a memorial to H. M. Secretary of State for the Colonies, urging the expediency of inquiries on the laws, customs, land tenure and tribal system of the natives, and on the other points dealt with in these pages. At that very time, as the readers of NATURE know, the Anthropological Institute and the Folklore Society were independently presenting a joint memorial making a similar request. The history of Christian missions, the history of every attempt by Europeans to rule a savage or barbarous people, is full of failures and bloodshed attributable to imperfect comprehension of native customs and ways of thought. So long as the missionary societies and the Colonial Office agree in ignoring the necessity of anthropological studies these failures will be repeated. In 1881, however, the Cape Government awoke to the desirability of ascertaining and recording some facts concerning native customs. A Commission was appointed, and its Report is, so far as it goes, an extremely valuable document. "There is urgent need," say the editors of the present volume, "of a similar inquiry covering the other territories of South Africa under British rule." When this protracted war has ended we shall have to make new laws in the Transvaal and the Orange River Colony to control the relations of the black men to the white, and of the black amongst themselves. We cannot legislate without first knowing the existing facts. A Commission of Inquiry would therefore seem inevitable. If it be determined on, it is to be hoped that scientific assistance will be called in, with a view to rendering the results complete and trustworthy, and, further, that it will be found possible to extend the area of its inquisition to Bechuanaland and to Rhodesia. That such an inquiry, if adequate in scope and properly directed, will incidentally be of high value to various departments of science (notably, but not exclusively, to anthropology) is an additional reason for the appointment of the Commission. In the pages of "The Natives of South Africa" scientific considerations are not adduced; but even without them the book is a powerful plea for inquiry, and one which may be heartily commended to all who are interested in the serious questions it presents for solution.

The Committee have given an interesting and useful appendix of selections from their correspondents' replies, and three maps showing the distribution of population in Cape Colony and Natal. Quite as necessary as either of these maps is one or more showing the locations of the different tribes in all the territories. These should have been given. Many of the tribes can certainly be located. If all cannot be, the defects would have been a striking illustration of the state of our ignorance.

E. SIDNEY HARTLAND.

PROGRESS IN THE COMING CENTURY.

Twentieth Century Inventions: a Forecast. By George Sutherland, M.A. Pp. xvi+286. (London: Longmans and Co., 1901.) Price 4*s.* 6*d.* net.

THE *rôle* of prophet of the industrial development ot the discoveries of science is one not lightly to be assumed, especially if it is the aim of the prophecy to cover so long a period as a hundred years. Mr. Sutherland has, nevertheless, had the temerity to attempt this task, and to approach it in the spirit of the man of science deducing logical conclusions from definite data rather than in that of the writer of fiction giving free rein to his imagination. We are not sure whether, when a century is concerned, the imaginative method, if kept within proper bounds, is not almost as satisfactory as the other. The predictions of the novelist are often fantastic and wild; but if he is likely to overshoot the bounds of probability his more cautious brother prophet is almost certain to fall short of them. The system of the logical prophet has, indeed, an inherent defect—it can only foretell the development and further application of knowledge that has already been acquired, and cannot take into consideration the possibility of the discovery of new facts. Yet it is by discovery as much as by invention, if we may draw a distinction between the two, that progress has taken place in the past, and it is to be hoped, for the sake of science, that the same will be true in the future. No prophet writing in 1801 on the same lines as Mr. Sutherland could have foretold the present development of electric traction, for he could not have foreseen the discovery of electro-magnetic induction made by Faraday thirty years later. He might, however, have predicted the modern railway systems, because the essential principles of these systems were already known. It would be easy to multiply instances, but we think it is evident from what we have said that Mr. Sutherland's prophecy must in some respects fall short of the truth, unless, indeed, the coming century is to be devoid of discoveries.

But if Mr. Sutherland's system is open to objection on the grounds that have been stated above, it has also much to recommend it. It would be idle to devote time to the serious consideration of extravagant predictions of the purely imaginative writer whose prophecies must be judged by their consistency and their power to interest. With the forecast in the book before us it is different; it is well considered and carefully thought out, and affords material for thoughtful, and very possibly useful, reflection. It is of interest to all those who are engaged in helping onward modern industrial development to pause occasionally and look somewhat far ahead to see in what direction that development is tending. Those who wish to take such a journey into the future cannot do better than make it under Mr. Sutherland's guidance. He points out clearly, and in many cases we think rightly, what are likely to prove the most important inventions in the twentieth century. It is, perhaps, necessary to state that the author counts inventions as belonging to the period during which they come to fruition rather than to that in which the original idea is first conceived; some such limitation is certainly necessary, otherwise there will never be wanting those who will be ready to prove that there is nothing new under the sun, and that the germ of the *Turbinia* was contained in Noah's Ark.

A great deal of space is justly given to the generation, storage and distribution of power. This is becoming one of the most pressing problems of the immediate future, as is evidenced by the number of big power schemes now on foot. We already see the new industries requiring much energy congregating around large sources of water-power. This source has only just begun to be seriously tapped, and for a time, at least, we can regard it as an almost inexhaustible supply of cheap power. But as progress goes on, as these industries develop and increase, water-power will no longer remain so cheap, for land will get more valuable in the neighbourhood of suitable waterfalls, and the available power will be, sooner or later, all in use even though the falls possess so large a reserve as Niagara. We shall then have to turn to other sources as yet untouched; it is to the winds and the waves that we shall go for help, according to Mr. Sutherland. Such sources as these, however, are intermittent and can only be useful when a thoroughly satisfactory means of storing power has been found. For this we must look to the electric accumulator, especially as the electrical seems to be the most suitable method of transmitting power. The author enters into detail at considerable length concerning the inventions by means of which the wind and wave power will be "cabin'd, cribb'd, confin'd," and here we must confess we do not think him so convincing. Throughout the book there is a tendency to enter into too minute details; it will be long before many of the problems are seriously attacked, and by the time they are it is probable that we shall have better means of attacking them than are now at our command.

Transport, both by sea and land, is another very pressing question. It is being very generally recognised that some method of relieving the congestion of the towns must be found, and it is probable that this will be most readily effected by increasing the ease of locomotion, though the transmission of power, by taking the work to the labourer in place of bringing the labourer to the work, will no doubt be a great help. Mr. Sutherland's schemes for increased facility of transport by road and rail are, many of them, suggestive and will be read with interest.

Space forbids our following Mr. Sutherland further into the coming century. We are inclined to disagree with his predictions concerning the future of music, art and many of the minor applications of electricity. We do not, for example, believe that wireless telegraphy will ever be used for lighting (and we suppose laying) the morning fire, that the housemaid of the future may not have to come down to a cold room. But, on the whole, the book takes a comprehensive and broad survey of the probable progress of invention, and is well worth careful reading.

VERTEBRATE HISTOGENESIS.

Lecithoblast und Angioblast der Wirbelthiere. By Wilhelm His. Abhandlungen der math.-phys. Classe der Kgl. Säch, Gesell. der Wissenschaft, vol. xxvi. pp. 173-328; 102 figures. (Leipzig: 1900.) Price Mk. 8.

THIS memoir is the latest and largest of a series, published by the author in the *Transactions* of the Saxon Academy of Science. Its title indicates that it treats of histogenetic studies in those parts of the developing germ which are concerned in the formation of the blood-vessels and blood, and in the elaboration and assimilation of the yolk-mass. The table of contents at the close reveals a very much wider sphere of research than that suggested by the title. It is, indeed, a treatise on histogenesis. Prof. His himself describes it as a sort of histological testament. Like some other documents of the like name, it contains very varied provisions. Almost all the phenomena witnessed in the early development of the embryo are treated of at greater or less length, the first blood-vessels and blood and the changes undergone by the yolk and its components receiving special attention. The work is full of detailed observations, and these are described at the hand of a complex terminology.

Following the plan of certain of his previous studies, the author has departed from the usual custom of gathering the illustrations into plates. And there can be no question that the numerous woodcuts woven into the text add greatly to the usefulness of the memoir. If the work contain no strikingly novel or fundamental discovery, it may none the less be described as a valuable storehouse of exact observations for the use of future investigators.

One of Prof. His's most remarkable recent discoveries —originally published in an earlier study—is again dealt with in connection with the yolk-germ or lecithoblast. It is that, underlying the so-called amitotic or direct division of the yolk-nuclei or merocytes, there is a modification of ordinary mitosis, *i.e.* a pluripolar form. This identification is probably to be regarded as among the greatest real advances in cytology of recent years. For does it not bring the unknown and incomprehensible into relationship with the known?

It may, however, be doubted whether, as the author maintains, the products of pluripolar mitosis—if the process attain any particular complexity—are ever able to revert to the bipolar form; indeed, whether cells which have got entangled in this complex network are ever able to emerge therefrom as normal entities. Connected with this question there is also the curious amœboid mode of yolk-annexation by certain cells described and figured in the memoir. Rueckert demonstrated some years ago—and his observations have recently been fully confirmed by Beard—that a tendency to free themselves from the yolk is often one of the characteristics of cells undergoing pluripolar mitosis. Like the latter process, that recorded by His as yolk-annexation would therefore be classifiable as a degenerative phenomenon.

The task undertaken in these histogenetic studies was an immense one—even for an investigator of the energy and talents of Prof. His—covering, or attempting to do so, a large portion of the field of developmental mechanics. How is it that certain structures arise at certain, usually predestined, times in particular places, and only there and out of certain cells alone? The simplest answer, and that long made the basis of almost all embryological research, has been that out of three primary layers of cells the embryo and all its parts take their origin. The working out of the details has largely been the labour of embryological investigation of the past fifty years.

The wealth of observation contained in the present memoir furnishes ample evidence that after all progress has been exceedingly slow.

We still do not know why a certain cell becomes a gland-cell, another a ganglion-cell: why one cell gives rise to a smooth muscle-fibre, while a neighbour forms voluntary muscle. The prolonged researches of Prof. His, often of far-reaching import, and always carried out with exceeding care, afford typical instances of investigation on the lines of development by epigenesis. The author himself states that as a solution of all, or even many, of the great problems of histogenesis they have disappointed his hopes.

It would appear to be quite possible that numbers of embryological problems incapable of any fundamental solution may exist. The range of human mental vision may have been reached with the limitations of microscopic lenses. However that may be, it is daily becoming more apparent that epigenesis with the three layers of the germ furnishes no explanation of developmental phenomena.

"There is no coming into being!"—"Es giebt kein Werden"—wrote Haller long ago. And this is emphasised by Weismann when he informs us that an epigenesis is an impossibility. But there is an evolution or unfolding. Development, even in lowly forms of animal life, is a complicated study. With three germ-layers as its basis no advance in its interpretation is possible. Nothing like all the cells present at the close of the egg-cleavage are destined to share in the formation of the future embryo. Many of them—often the majority of them—are merely larval or transient in character. Still others, the greater number of those remaining, are charged with the duties of handing on the "stirp," in Galton's sense, to future generations.

The chain of life from generation to generation is of exceeding intricacy. The unravelling of the tangle and the true interpretation of the many important links in it both serve to increase the magnitude of the embryologist's task. The day is not yet when this approaches completion.

OUR BOOK SHELF.

The Scientific Memoirs of Thomas Henry Huxley. Vol. iii. Edited by Sir Michael Foster and E. Ray Lankester. Pp. xi + 622. With thirty plates, maps and text illustrations. (London: Macmillan and Co., Ltd., 1901.) Price 30*s.* net.

THIS magnificent volume will be to the working naturalist the most welcome of the three now published. It contains 38 memoirs, papers and addresses, covering, in all, 608 pp., as against 50 with 508, and 37 with 591 for volumes i. and ii. respectively. It embodies the scientific work of Huxley at his best. As memorable may be cited the great memoir on the bird's palate, which marked an epoch in comparative osteology; and that on the ossicula auditus, in which recent research has discovered a hidden treasure, and of which one of the leading conclusions, viz. that of the primary nature of the union between the hyoid and the columella auris, has but lately been shown (long opposition notwithstanding) to be developmentally confirmed. Particularly noteworthy are the series of memoirs and papers upon the Dinosauria, and the series of addresses and philosophic memoirs on the ethnology, archæology and distribution of mankind in various parts of the globe, which will ever rank among their author's best achievements.

As regards the general get-up of the book, the editors have spared no pains to render perfect their labour of loyal devotion. One or two of the plates are, perhaps, a little lacking in sharpness—printed, in the copy before us, a little lightly—but all that is important is definable.

It is with a feeling of considerable relief that we note the incorporation of the Geological Survey memoir upon the Structure of the Belemnitidæ; for this, in respect to certain details, contains the most accurate description to-day available, and will ever hold its original high place in the literature of zoology. Our expression of relief is due to the fact that this great essay, together with five of those afore-mentioned in anthropology, the two papers upon the lowly plant organisms which close the present volume, and one or two other items, were entirely omitted in the first-published table of "contents," put into circulation on the announcement of the work. The reason for this is not difficult of demonstration, and while we would convey to the editors our gratitude for having, as their labour advanced, made perfect the definitive list up to the period embraced by the present volume, we would remind them that, so far as the said "contents" table affects the volume to come, the great Survey Memoir on the Elgin Crocodilia, the Rede Lecture on Animal Forms, delivered at Cambridge in 1883 and duly reported at some length in our own pages (NATURE, vol. xxviii. p. 187), with the "Further Notes on Hyperodapedon" (*Quart. Journ. Geol. Soc.*, vol. xliii., which was the last zoological paper that issued from Huxley's hands, were similarly not included.

In the production of this monumental series of volumes, publishers and editors are incurring a debt of gratitude on the part of the present and future generations; and carrying out a labour of love in a spirit becoming in its dignity the original memoirs themselves.

Fact and Fable. By Effie Johnson. Illustrated by Olive Allen. Pp. 117. (London: Chapman and Hall, Ltd., 1901.) Price 6*s.*

THIS is a pleasingly-written and attractive little book, containing a series of short tales and sketches, the first and largest of which relates a boy's visit to an ant-hill, his adventures, and what he found there. Another tale relates the adventures of a young bee; while most of the others consist of allegorical or symbolical presentations of various phases of human life. As the authoress admits, the descriptions of the events in ants' nests are taken from different species, and the large queen is a Termite. But the story may serve to interest young readers in ant-life and lead them to read other books on the subject.

Science and Mediaeval Thought. By Prof. T. Clifford Allbutt, F.R.S. Pp. 116. (London: C. J. Clay and Sons, 1901.) 2*s.* 6*d.* net.

THE brilliant character of the Harveian oration delivered before the Royal College of Physicians last October by Prof. Clifford Allbutt could be judged by the abridgment which we published a few days after the delivery of the address (vol. lxii. p. 630, October 25, 1900). The complete address is given in the volume before us, with a few additions and notes, and we cordially commend it to every one who desires to read an inspiring account of the evolution of mediæval into modern thought.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On a Form of Artificial Submarine Cable.

IN order to illustrate the effect which capacity has on the sending of arbitrary electrical disturbances along a conductor, Mr. C. F. Varley, about the year 1860, devised an artificial submarine cable equivalent in its action to a real cable long enough to reach from England to Australia. For obvious reasons such a device would be a most instructive piece of lecture-table apparatus.

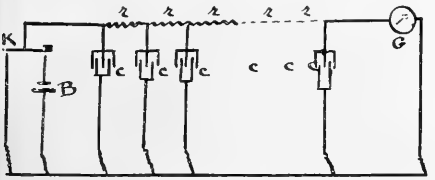
The so-called "K.R. Law" of Lord Kelvin states that the time-lag in signalling over a cable is proportional to the capacity of the dielectric sheathing per unit length, to the resistance (also per unit length), and to the square of the length.

Thus in order that the time-lag of an artificial cable shall be great, both the resistance and capacity must be great. The first of these two conditions is, of course, easily fulfilled, but if the ordinary tin-foil type of condenser is used as the capacity, both the bulk and cost of the apparatus is very considerable.

For this reason very few artificial cables have been made after Varley's plan. I have recently made an artificial cable, giving about six seconds time-lag, which is entirely free from the disadvantages just mentioned, and for this reason I trust that it may commend itself to teachers of physics as a piece of demonstration apparatus.

In an actual cable the capacity is distributed uniformly along the length of the line, but in an artificial cable of great equivalent length the capacity must be distributed non-uniformly in some such way as that shown in the accompanying figure.

In it B is the battery, K a double key so connected as to put the cable either to the ungrounded pole of the battery or to



Earth.

earth, *r r* are a number of high resistances which play the part of the conducting core of the cable, and *c c* are the capacities which play the part of the insulating sheath of the cable. G is the galvanometer, one side of which is connected to earth, and forms the receiving end of the apparatus.

This is substantially the arrangement which Varley used, the only difference between his artificial cable and mine being that I have substituted light, easily made electrolytic capacities for the bulky, expensive commercial capacities used by him.

As is well known, the polarisation capacity of platinum electrodes in dilute sulphuric acid is very great. Unlike true dielectric capacity, it is not independent of the charging potential, its value increasing with the charging potential and reaching a value as high as 500 micro-farads per square inch of electrode surface.

Even though the capacity of such a cell is not a fixed quantity we may make use of its great value in constructing an artificial cable, though, of course, we are then obliged to use a battery at the sending end having an E.M.F. less than the maximum polarisation of the electrolytic cell.

The capacities I used were made by fusing platinum wire into the ends of little cells made of glass tubing. These were filled with water and a piece of platinum foil was corked into each so as to dip a few millimetres into the water.

I made thirty-six such cells and mounted them on a board in which holes were drilled to allow the platinum wires to project through so that they might dip into a trough filled with mercury which was connected to earth. These thirty-six cells were divided into twelve sets of three cells in parallel, and each of the twelve sets were connected in the positions *c c* of the figure. The resistances *r r* aggregated about a million ohms.

The advantage of mounting the cells on the board as described is that the action of the cable when the platinum wires are in the mercury (and hence the capacities in, as shown in the figure) can be rapidly compared with the action when the capacities are out. In the latter case the apparatus represents an overhead line of resistance equal to that of the cable.

With the apparatus as described the galvanometer responds as soon as the key is closed in case the capacities are out, but if they are in there is a time-lag of about six seconds.

A. TROWBRIDGE.

Physical Laboratory of the University of Wisconsin, U.S.A.

Electro-Chemistry.

MY attention has lately been directed to your review of my book on "Practical Electro-chemistry" (April 18, p. 582). I desire to thank you for noticing a modest effort at length. Your reviewer is in error in supposing that the series system of copper refining is now of any commercial importance. The process was founded on a delusion and is dead. The working up of anode sludge, mentioned by your reviewer, is a purely chemical question and does not fall within the scope of the book. I note with interest that a method has been devised for refining tin, but I do not anticipate its general adoption; gold and silver being absent from crude tin it is hardly to be expected that the anode sludge obtained in the process of refining will be worth exploitation. The electrolysis of chlorides to produce chlorates is an important branch of electro-chemical industry, and omissions of details in my book, quite fairly remarked by your reviewer, are due less to indolence on my part than to the impossibility of obtaining authentic information. Manufacturers, even in the United States, where a liberal spirit prevails, are chary of allowing entry to their works. A somewhat persevering inquiry at Niagara convinced me of this reluctance. But in spite of this difficulty I am well assured that the competent chemist, equipped with a sound knowledge of the principles of electrolysis, need not fear to engage in the practice of this the latest and most promising of industries.

BERTRAM BLOUNT.

Westminster.

WITH reference to Mr. Blount's letter—if the "series system" of copper refining was "founded on a delusion" it appears to have been a fairly successful delusion. If Mr. Blount consults "The Mineral Industry" for 1899 he will see that the Baltimore Copper Smelting and Rolling Co., which uses this system, turned out between 60 and 70 million pounds of refined copper in 1898. The Nichols Chemical Co., N.Y., whose daily output of refined copper amounts to 60 tons, also employs this method (or did in November 1899).

Mr. Blount further states that gold and silver are absent from tin and therefore "it is not to be expected that the *anode sludge* obtained in the process will be worth exploitation." Mr. Blount is probably thinking of Cornish tin, but Mr. Claus's process has been devised for purifying South American tin, some of which contains considerable quantities of gold and silver, *e.g.* an *anode sludge* analysed for Mr. Claus contained 698 ozs. silver and ½ oz. gold per ton (1 ton of *anode sludge* would be obtained from about 10 tons of crude metal). In another analysis the crude anode gave 7 ozs. silver and 1 oz. gold per ton.

I am still of the opinion that Mr. Blount would have considerably added to the value of his book had he described in detail the working up of a "typical" anode sludge. The successful treatment of the sludge is extremely important to the practical electro-chemist, and if a description of it is outside the scope of a book devoted to electro-chemistry, I fail to see in what book it should be described.

In the third place I did not accuse Mr. Blount of being "indolent"; if he were so he would not sit down and write a book of nearly 400 pages. An author must of necessity use his own judgment, as to what he will include and what he will reject, in writing a book. It does not, however, follow that the reviewer will agree with him.

F. MOLLWO PERKIN.

Specimens of "Aecidium berberidis."

THERE is a barberry bush near where I live which usually bears on its leaves a number of cluster cups (*Aecidium berberidis*). They are just appearing.

Perhaps some of your readers might care for a few specimens. If so, and if they would communicate with me, I should be pleased to send them a supply.

J. LEWTON BRAIN.

Swanton Morley, Dereham, May 20.

THE BRITISH ASSOCIATION MEETING.

THERE is every indication that the coming meeting at Glasgow will be an unusually large one, and the local committee is putting forth every effort to make it a success in every way.

The last meeting in Glasgow was in 1876, under the presidency of Dr. Andrews, F.R.S., professor of chemistry, Queen's College, Belfast, and the attendance was 2774. At that date the population of Glasgow was about 500,000, and now it is considerably more than 760,000, or, including the neighbouring burghs, about one million. But the expectation of a large meeting is based, not only on the increased population, but also on the increased attention paid locally to scientific pursuits and to the circumstance that an International Exhibition of Industry, Science and Art is being held in the Kelvingrove Park, adjacent to the University Buildings, where all the sectional meetings are to take place.

Four very important additions have been made to the buildings of the University since the Association last met in Glasgow. The Bute Hall is to be used as a reception room, and from its position and size it lends itself admirably to that purpose. Large and commodious anatomical rooms have been completed, and separate handsome buildings for botany and engineering are expected to be finished in time for the meetings. Thus, in the class-rooms of the University, there will be ample room for all the section meetings and conferences. The first general meeting will be held at 8.30 p.m. on Wednesday, September 11, in the St. Andrews Hall, when the president-elect, Prof. Arthur W. Rücker, Sec.R.S., will deliver the opening address. In the same hall, which will accommodate considerably more than 3000 persons, the Friday evening lecture will be delivered by Prof. William Ramsay, F.R.S., and the Monday evening lecture by Mr. Francis Darwin, F.R.S. The Saturday evening lecture to workmen will be delivered in the City Hall by Mr. H. J. Mackinder.

On Thursday evening, September 12, the Corporation of the City of Glasgow will give a conversazione and reception to the members in the City Chambers, and on Tuesday evening, September 17, the Executive Council of the International Exhibition will give a conversazione and reception in the Fine Art Galleries within the Exhibition grounds. This building is considered to be one of the finest in this country and consists of a central court, 125 feet by 56 feet, with two courts, each 102 feet by 60 feet, east and west of the hall; also twelve galleries averaging 100 feet by 28 feet, aranged in two floors around the courts. The collection embraces the following divisions :—

(1) Oil-paintings of the nineteenth century.
(2) Water-colour paintings of the nineteenth century.
(3) Sculpture and architecture.
(4) Works in black and white.
(5) Photography.
(6) Art objects.
(7) Scottish archæology and history.

The conversazione in the Art Galleries will therefore be of special interest.

The Royal Scottish Society of Painters in Water Colours will give a conversazione on September 18, and the Faculty of Physicians and Surgeons will give a dinner to the medical members of the Association on September 16; and other public bodies in the city are expected to cooperate in a similar manner. Lord Overtoun has kindly offered to entertain the members at a garden party at his seat at Overtoun, Dumbartonshire, probably on the afternoon of Monday, September 16; and another garden party will be held in the Botanic Gardens on the afternoon of Friday, September 13.

Excursions are limited this year to Saturday as, by resolution of the general committee, the local committee has been requested not to arrange for any whole day excursions on Thursday, September 19. On Saturday, September 14, there will be excursions to :—

1. Loch Lomond, where the party will be entertained to luncheon by the kind invitation of the Duke of Montrose, Lord Overtoun, Sir James Colquhoun of Luss, Mr. Crum Ewing of Strathleven, Dr. Jacks of Crosslet, Mr. Campbell of Tullichewan, and others.

2. The Roman Camp at Ardoch, Doune Castle and Dunblane Cathedral, where the party will be entertained by Sir James Bell, Bart.

3. Craignethan Castle (Tillitudlem), Lanark and Falls of Clyde, where the party will be entertained to luncheon by the Right Hon. the Earl of Home.

4. Stirling, where the party will be entertained to luncheon by the Town Council of Stirling.

The Howieton Fishery Company has kindly agreed to allow the excursionists to inspect the interesting fish ponds at Sauchie.

5. Paisley, including visits to the Abbey, Coats Memorial Church and Paisley Thread Works, where the party will be entertained by Sir Thomas Glen Coats.

Other excursions are in contemplation, including a sail down the river; but the arrangements have not yet been completed.

A large number of the clubs and libraries in Glasgow have kindly agreed to admit non-resident members as honorary members on presentation of their membership tickets. Full particulars of these will be given to members in the reception-room.

Glasgow, being situated in a district rendered famous by the genius of romance, and still more famous as the theatre of many of the most thrilling events in Scottish history, is well known to be the seat of some of the most extensive trading and manufacturing interests of the country; its engineering and shipbuilding works, its cotton and chemical manufactories and its iron trade are world famous. Arrangements are being made to allow members to visit some of the more important establishments at stated times during the meeting, including engineering works, shipbuilding works, ironworks, mills, locomotive works, printing works, pottery manufacturing, chemical manufactories, &c.

In 1876, when the Association last met in Glasgow, the local committee prepared three handbooks, which have remained until the present day as valuable books of reference for men of science and other students of the fauna, flora and geological features of the Clyde district. Following this precedent, the local committee for this coming meeting is also preparing three handbooks. The first is to deal with the general industries of Glasgow and the Clyde, and will deal with, among other subjects :—

(1) Mining and Quarrying, by Mr. G. R. Thompson; (2) Metallurgy, by Prof. A. H. Sexton; (3) Mechanical Engineering, by Dr. H. Dyer; (4) Marine Engineering and Ship-Building, by Dr. R. Caird; (5) Transport, by Mr. D. T. Sandeman; (6) Textile and Allied Industries, by Mr. Robert Macintyre; (7) Chemical Industries, by Prof. G. G. Henderson; (8) Pottery, Glass, etc., by Mr. James Fleming; (9) Municipal Enterprise and the Clyde Trust, by Mr. John S. Samuel. Principal Angus Maclean, Technical School, Paisley, is the editor of this volume.

The second handbook, on the fauna and flora of the Clyde valley, is under the general editorship of Dr. M. Laurie and Mr. G. F. Scott-Elliott. For the flora part of the handbook the main contributions are: (1) Introduction, by Mr. G. F. Scott-Elliott; (2) History of Botany, by Prof. F. O. Bower, F.R.S.; (3) Phytoplankton, by Mr. V. H. Blackman and Mr. G. Murray, F.R.S.; (4) Freshwater Algæ, by Messrs. T. Paterson, J. M. Taylor and W. W. West; (5) Diatoms, by Messrs.

T. Comber and T. Paterson; (6) Marine Algæ, by Mrs. Robertson, Messrs. E. M. Holmes and L. Batters; (7) Characeæ, by Mr. P. Ewing; (8) Lichens, by Mr. G. F. Scott-Elliott; (9) Fungi (microscopic), by Mr. D. A. Boyd; (10) Fungi (hymenœnycetas), by Mr. W. Stewart; (11) Fungi (gastromycetas), by Mr. R. B. Johnstone; (12) Hepaticæ (Liverworts), by Mr. P. Ewing; (13) Musci, by Mr. J. Murray; (14) Filices (Ferns), by Mr. W. Stewart; (15) Phanerogams, by Mr. P. Ewing.

The geological part of the handbook which is edited by Dr. Malcolm Laurie has, among others, the following contributions:—Introduction, by Mr. John Horne, F.R.S.; Metamorphic Rocks, by Mr. Peter Machair; Silurian formation, by Mr. John Horne, F.R.S.; Graptolites, by Prof. Lapworth, F.R.S.; Coals, by Mr. James Thomson; Old Red Sandstone, by Mr. J. G. Goodchild; Carboniferous Formation, by Mr. J. B. Murdoch; Plants, by Mr. R. Kidston; Corals, by Mr. James Thomson; Ostracoda, by Prof. R. Jones and Mr. T. Kirby; Brachiopoda and Gastropoda, by Mr. James Neilson; Fishes, by Dr. R. H. Traquair; Permian Rocks and Glacial Clays, by Mr. John Smith; Drift Beds and Raised Beaches, by Mr. James Steele and Mr. Thomas Scott; Rocks and Minerals, by Messrs. J. Sommerville, G. R. Thompson and J. G. Goodchild. Mr. Wm. Armour, C.E., is preparing a special geological map of the Clyde Valley for this part of the handbook.

The third handbook is to deal with (*a*) archæology of Glasgow, (*b*) educational institutions of Glasgow, and (*c*) the medical and charitable institutions of Glasgow. The contributors to part (*a*) are Mr. Robert Renwick, Town Clerk Depute of Glasgow; Mr. J. Neilson, procurator fiscal; and Mr. P. MacGregor Chalmers, who is contributing an article on the Glasgow Cathedral. Dr. J. G. Kerr is editing part (*b*), and some of the more important articles will deal with The University, by Mr. W. Innes-Addison; The Technical College, by Mr. H. F. Stockdale; The Training Colleges, by Mr. G. W. Alexander; Agricultural College, by Prof. Wright; Libraries, by Mr. Barrett; Secondary Education, by Dr. J. G. Kerr; and Primary Education, by Mr. G. W. Alexander. Part (*c*) is edited by Dr. Dickson; and contributions on the different medical institutions are given by experts such as Dr. Dalzell, Dr. Lindsay Steven, Dr. Alex. Napier, Dr. F. Fergus, Dr. Finlayson, Dr. Chalmers, and others. Prof. Magnus Maclean is the editor of this volume.

Messrs. Bartholomew are getting ready a specially prepared map. This map, along with one of the handbooks, will be presented to each member who attends the meeting, and copies of the other two handbooks may be purchased by members at a reduced price.

A large number of members from different parts of the United Kingdom have already indicated their intention of being present, and a number of foreigners have also sent in their names, including representative mathematicians, engineers, physicists, botanists and zoologists from Europe and America.

It has been agreed between the different railway companies that return tickets at single fare and a quarter will be issued, from all the principal stations in the kingdom to Glasgow, to members of the British Association, on surrender of a certificate signed by the secretary of the Association to be obtained in the beginning of September from the hon. local secretaries, 30, George Square, Glasgow. The tickets will be valid from *the day before the first meeting until the day after the last meeting.*

The following are the presidents of sections:—Section A (Mathematical and Physical Science), Major P. A. MacMahon, F.R.S.; B (Chemistry), Prof. P. Frankland, F.R.S.; C (Geology), John Horne, F.R.S.; D (Zoology), Prof. J. Cossar Ewart, F.R.S.; E (Geography), Dr. H. R. Mill; F (Economic Science and Statistics), Sir Robert Giffen, F.R.S.; G (Engineering), Col. R. E. Crompton; H (Anthropology), Prof. D. J. Cunningham, F.R.S.; I (Physiology), Prof. J. G. McKendrick, F.R.S.; K (Botany), Prof. J. B. Balfour, F.R.S.; L (Educational Science), Rt. Hon. Sir John E. Gorst, F.R.S.

It is not anticipated that there will be any difficulty in accommodating the members at Glasgow. There are a large number of comfortable hotels and the committee is preparing a list of such hotels, as well as of suitable lodgings and furnished apartments. Many Glasgow citizens have also indicated their desire to offer private hospitality to members. The Secretarium will probably be in Queen Margaret Hall, which is situated within five minutes walk of the University.

MAGNUS MACLEAN.

THE RECENT TOTAL SOLAR ECLIPSE.

THE several parties of observers who journeyed so far to see the eclipse on Saturday last were not, it appears, favoured with such good weather conditions as obtained during the previous two eclipses in India and Spain. No detailed accounts of the results are yet to hand, but from several brief telegrams in the daily Press we may gather a summary of the general observations made.

Mauritius.—The observers at the Government Royal Alfred Observatory at Mauritius appear to have had the greatest success. Even here the partial phases were only incompletely determined owing to clouds, the first contact being quite lost; the last three contacts were, however, determined fairly well. The party at this station consisted of twenty-two observers. With respect to the total eclipse itself, fifty-two photographs of the corona were obtained with the Mauritius photoheliograph, the Greenwich coronograph, the Newbegin telescope and several smaller cameras. In addition, forty-one photographs of the partial phase were taken for determining the diameter and place of the moon as a control over the ephemeris data, and eighteen photographs of the spectrum of the eclipsed sun's surroundings.

Drawings were made with a 6-inch telescope, and a kinematographic record of the eclipse also obtained.

Mr. Claxton had organised a comprehensive scheme of meteorological observations. The general report from this station is that the corona was of the expected minimum type, but fainter, more yellow and diffused than that observed in Spain last year.

Sumatra.—The expeditions to the Eastern Archipelago did not have a clear sky during totality. The instruments from Greenwich, in charge of Messrs. Dyson and Atkinson, were set up on the volcanic island of Auer Gedang, about six miles from the coast of Sumatra, on the central line of totality. Here the sky was covered with heavy rainclouds during the morning, rendering the prospect anything but hopeful. A slight improvement took place as the time of eclipse drew near, but unfortunately the sky never quite cleared. The form of the corona was observed, and the planets Mercury and Venus seen. Totality lasted 6 min. 21 sec.

The Dutch party in the same neighbourhood—at Karang Sago—were somewhat more successful, although there the sky was throughout covered with thin clouds.

Successful photographs are reported to have been obtained of the corona with different telescopes, and photographs of the spectra of the corona and chromosphere with two spectrographs. Several other branches of investigation, including photographs with the prismatic camera, measurements of polarisation of coronal light and determination of heat radiation of the corona, were unsuccessful.

The observations at the inland station of Solok were an almost total failure.

At Singapore the eclipse was very well seen, totality occurring about 12.51 p.m. An interesting series of observations of the temperature variations were made there. The reading before eclipse in full sun was 143°, which fell during totality to 81°, which was 2 degrees below the normal shade temperature.

RECENT WORK OF THE U.S. WEATHER BUREAU.[1]

THE Report of the Weather Bureau for the year ended June 30, 1899, which appeared at the end of last year, extends over two volumes. The first, which includes the usual administrative report and the climatological statistics of the United States Weather Service, is a volume of the ordinary dimensions, while the second and special volume, being part vi. of the whole report, is devoted to Prof. Bigelow's discussion of the United States' contribution to the international cloud observations. It is a bulky volume of no less than 787 quarto pages.

Glancing at the first volume, attention is turned naturally to those points in which the practice of the United States Weather Office differs from that adopted in this country, and the first point to be noticed is that from March 1899 the period covered by the night forecasts was increased to forty-eight hours, and that the extension of period has worked successfully, whereas the limit of the British forecasts is twenty-four hours. It is true that the British Isles occupy a remarkably difficult position on a weather map. They are not only at the extreme west of Europe and catch the first effects of weather changes travelling eastward, but they are in a special manner the battle-field of the elements and are vexed with all the storms that belong to so-called temperate latitudes and western shores. These adverse circumstances in a British mind should provoke more daring enterprise rather than complacency with partial successes, yet we are still without telegraphic reports from Iceland, a recognised centre of atmospheric influence, and wireless telegraphy has not yet extended westward the available area of information.

The weather service in the United States is indeed a popular one. From a table in the report it appears that the total number of addresses in the United States supplied with forecasts and special warnings reached the astonishing figures of 24,467,106. With these no British statistics can be compared.

It would require too much space to enter into details of the climatological data, which include, amongst other things, means of hourly readings at 28 stations. It should, however, be remarked that the year under review was noteworthy for the establishment of a number of stations for the storm-warning service in the West Indies at the conclusion of the war with Spain, and for the extensive system of aërial investigation by means of kites at 17 stations. This work was continued until the middle of November, 1898, by which time 1217 ascensions of 1000 feet and above had been made.

The second volume, written by Prof. F. H. Bigelow, is devoted exclusively to the cloud observations made in accordance with international agreement between May 1, 1896, and July 1, 1897. It is a very interesting and valuable contribution to the study of meteorology by observation of clouds, and the discussion is very fully carried out. The observations were of two kinds—theodolite observations at Washington, by which observers could determine the actual heights and velocities of individual clouds, and nephoscope observations at 15 stations in the United States from which velocities were estimated by the somewhat precarious method of assuming the height of the particular type of cloud observed. The theodolite observations are printed in columns arranged according to the type of cloud observed, and occupy 93 pages of the volume. Their discussion leads directly to some very interesting results as to the variation of the velocities of clouds with height.

The nephoscope observations numbered some 23,000. In order to coordinate them the whole United States area is first divided into six districts, and the position of each station for each observation with regard to a centre of high or low atmospheric pressure is identified by assigning it to one of twenty subsidiary areas within a circle of 1500 kilometres surrounding the centre of high or low pressure, as the case may be. In this way the distribution of velocity round the centres of "high" and "low" areas for each cloud level can be set out and the gradual change in distribution from the surface wind to the regular easterly march of the cirrus at about 10 kilometres height is traced.

In further discussion of the velocities at the different cloud levels, the general easterly drift at different levels is allowed for, and the residual vectors of velocity are plotted in diagrams to show the circulation components in "highs" and "lows" at the different cloud levels.

The same data enable the barometric gradients to be calculated, and the interesting results follow that the circulation phenomena are most vigorous in the middle group of cloud levels, viz. the Strato-cumulus to Alto-stratus group, and that there is no experimental evidence to show that there is an overflow of air from the upper part of a cyclonic area causing a higher pressure around it, as has been generally assumed.

The application of these results to the several districts of the United States in different typical states of weather is represented in 66 maps of the movement of the air at different levels over the United States. This completes the primary reduction of the observations. The remainder of the volume is occupied with the application of the inductive results obtained. First a section is devoted to the diurnal variation of the barometer. The diurnal variation of winds (taken from European stations) and of cloud motions at the alto cumulus, cirro cumulus and cirrus levels, taken from the cloud observations, is compared with the diurnal variation of magnetic force as part of a discussion of a possible relation between diurnal variation of barometric pressure and magnetic force. Without expressing an opinion upon Prof. Bigelow's own views, which have given rise to some controversy, it may be said that this discussion is very suggestive in view of the ideas which have recently been developed from Prof. Thomson's suggestion of "bodies smaller than atoms," Arrhenius and others, of the possible reception of particles from the sun carrying electrical charges which can move with the upper atmosphere.

Prof. Bigelow next deals with the general theory of atmospheric circulation in relation to the light thrown upon the subject by the cloud observations. He commences the discussion by a general review of his mathematico-meteorological troops. All the numerical, thermodynamical and hydrodynamical formulæ available for meteorological warfare are paraded for inspection by the reader, and they are clothed in a new uniform on account of the need for a standard system of notation for meteorology. The uniform does not always quite fit. "Pounds $\times$ (foot)^2" seems to require some sort of inversion before it can appropriately clothe pressure. But that is a small matter. The array of formulæ is very imposing, not to say repellent, and this part of meteorology needs a uniform that is less oppressive for the civilian meteorologist. But Prof. Bigelow's investigation moves generally upon sound lines. His criticism of Ferrel's solution of the problem of the local cyclone is sound, and his diagram (chart 69) representing the alternation of high and low areas as resulting from the play of pressure due to the action of two opposing streams of air is a very useful representa-

[1] United States Department of Agriculture. Report of the Chief of the Weather Bureau, 1898–9.

tion of the origin of the conspicuous barometric changes which are characteristic of middle latitudes.

The general scheme of Prof. Bigelow's contribution is to identify and describe the actual motion of the air. There is no doubt that the identification of the stream lines in the atmosphere is a most important step towards a dynamical theory of atmospheric phenomena. When these relations, which are, of course, strictly kinematical, have been satisfactorily established by observation and experiment, the transition to the dynamical explanation will be more practicable than any attempt to calculate the state of motion of the air *a priori* from assumed dynamical causes and conditions. The procedure from the observation and accurate identification of the actual motion, even if it be complicated, to the forces which produce it has for precedent the solution of the problem of planetary motion, and it is most interesting to see a similar process shaping itself in the less amenable department of winds and clouds.

Further applications of the observations are contained in chapters xii. to xiv., wherein the observations of cumulus and nimbus clouds, incorporated with kite and balloon observations, are used to throw light on the successive stages of change which take place in air as it rises from the surface; and the reductions necessary for pressure and temperature to enable an observer, with the assistance of cloud observations, to draw up a weather map for the 3500 foot level or the 10,000 foot level are discussed, while in chapter xiv. the heat necessary to convert an "adiabatic atmosphere" into the atmosphere in its existing state is computed.

The latter part of the book is technical and based upon mathematical reasoning, and the style is by no means easy. The earlier part is observational, except that of course formulæ are employed for reduction of the direction and magnitude of the motion of the clouds from the observed data. The whole work is admirably illustrated by large numbers of well executed charts upon which a great deal of the discussion is based.

It is too voluminous and important a work to criticise here in detail. What is most conspicuous about it is the easy coordination and correlation of so many different lines of meteorological research to form a definite idea of the real course of atmospheric changes. It is possible, and even probable, that the generalisations have gone a little further than the extent of the observations warrant at present, but the discussions show in what an important manner the general study of meteorology is affected by cloud measurements, and it suggests ideas which are certainly capable of confirmation, or possibly contradiction, by further observations. They make the reader feel that observations of the height and motions of the clouds are a matter, not merely of statistical interest, but may lead to the solution of most important problems in the physics of the atmosphere and may throw light even on the obscure phenomena of terrestrial magnetism.

The Weather Bureau is much to be congratulated upon the production of a volume at once so practical and so scientific amongst its official publications.

A CANADIAN GEOLOGICAL EXPLORER.

SOME few weeks back it was announced in NATURE that Dr. Robert Bell, F.R.S., of Ottawa had been appointed director of the Geological Survey of Canada. It is an interesting coincidence that Mr. Charles Hallock has recently written and dedicated to the National Geographical Society of Washington, D.C., a paper dealing with his explorations. This American recognition of a Canadian geological explorer is so remarkable that we desire to call attention to it, especially as it gives an idea of the new director's life work, the extensiveness of which will astonish many. Mr. Hallock, who has been acquainted with Dr. Robert Bell for thirty years, is only able to give us a very brief review of what has been accomplished by this exceptionally able and energetic geologist, for the account is a short one, but we feel that it is of such general interest that the following few facts may be stated.

Dr. Robert Bell commenced his career at fifteen. At that age, and in the year 1857, he joined the Geological Survey under the late Sir W. E. Logan, then director, and served for three years as assistant to the principal members of the staff. Since then he has continued in the same work, but has acted as chief member of the various parties.

His surveys include portions of nearly every part of Canada. Beginning in the east, they comprise the "Gaspé Peninsula, from Percé to Rimouski and from the St. Lawrence to the Baie des Chaleurs, and thence to Quebec, the eastern townships, the Saquenay and Lake St. John Region, the north shore of the Gulf of St. Lawrence, the west coast and the interior of Newfoundland and parts of Nova Scotia and New Brunswick." Dr. Bell has coasted round the eastern, or Atlantic, the northern and the western coasts of the Labrador peninsula, and also round some of the islands lying off the the coast. He has calculated that the peninsula is 560,000 English square miles, a region greater than the combined areas of Great Britain and Ireland, France, Germany, Belgium and Holland.

In the summer of 1897 he visited Baffinland and surveyed most of its southern coast, besides exploring the interior, where there are many large lakes. It is worth mentioning here that only one of these lakes had before been seen by a white man. This great island of Baffinland is 1000 miles in length, and is only exceeded by Greenland and Australia in size.

The large island at the north end of Hudson Bay he has also explored, and has surveyed to a great extent the whole of the east coast of the Bay, from the Straits to the head of James Bay, also parts of the west coast of this vast inland sea, which was termed by him "the Mediterranean of North America."

Surveys have been made of the rivers flowing into James Bay. The Noddaway is the largest, and its great west tributary has been named the Bell River, after attention had been drawn to it by this eminent explorer. The rivers flowing into the Hudson Bay which he has surveyed comprise the Hayes, Steel and Hill, the great Nelson, with some of its tributaries, which drains the country as far as the Rocky Mountains, and the Great and Little Churchill rivers.

Coming further south we find his work comprises the Ottawa River from source to mouth, with its great tributary the Gatineau, and various neighbouring streams, the Montreal River and country north and south of it, and the country north of Lake Huron, including a great number of rivers and the mining district of Sudbury. The lake-peninsula of Ontario has been geologically examined by him, while he has surveyed the rivers on the north side of Lake Ontario, the Nipigon Lake, which is the most northern of the great lakes of the St. Lawrence, and also the rivers and their lakes and the country north of this to the Albany.

To the west of Lake Superior the wooded country to the prairies has been explored, and the international boundary line from this lake to the Lake of the Woods geologically examined by him. In 1881 he published a map of this last-named lake, the first ever made.

Still further west a track-survey of most of the shores of Lake Winnipeg was completed. Lake Manitoba was explored, and, further west still, the Assinniboine, Swan and Qu'Appelle Rivers and extensive portions of the North and South Saskatchewan River. A good track-survey has, further, been made of Lac la Biche and its river as far as the Athabasca River, and also of that river itself as far north as the Athabasca Lake.

On the steamship expeditions sent out by the Canadian Government to Hudson Strait and Bay, Dr. Bell not only acted as geologist and naturalist, but on the *Neptune* and *Alert* expeditions as medical officer as well.

The above is only a brief outline of the places Dr. Bell has visited and the work he has done, for no mention has been made of the time he has spent at the Great Slave Lake. This lake is 300 miles long and is a distance of 3000 miles from Ottawa, so no small journey! For the past few years, however, it has been possible to go a great part of the way by train and steamer. Here attention may be drawn to the fact that the work on the prairies and plains was accomplished before any treaties had been made with the Indians, and before the organisation of the mounted police. In those days, that part of the country was scarcely, if at all, settled, except further north, where it was practically only known to the Hudson's Bay Company's people. The buffalo was very plentiful then, and it may be surmised that the adventures of Dr. Bell were many and exciting. Taking into account all the discomfort from exposure and fatigue, the want of food, and the usual hardships connected with exploring, we may safely say that in the forty-four years of Dr. Bell's annual expeditions, he has had more adventures, more experiences of every description, and seen more of the fauna and flora of North America than any other white man living, besides having been brought into close contact with the real wild Indians, the Eskimos and the Hudson's Bay Company's people, and thus getting a thorough insight into their manners and customs.

During this time not only has he made geological, geographical and topographical surveys, but has collected a great quantity of zoological and botanical specimens, taken many photographs of these far-away parts, and made observations in a great many varied directions, greatly interesting himself in the folk-lore of the Indian tribes and the Eskimos. Dr. Bell has been called by Mr. George Johnson, the official Dominion Statistician, "the place-name father of Canada," for as his work has been so much in unknown parts he has had to give a great number of names.

In spite of the exposure and hardships he has had to experience, Dr. Bell is in perfect health and as keen and untiring about work as ever. He attributes his health to the care he has always taken of himself when camping out, always endeavouring to have a dry comfortable bed of brush or some substitute every night, trying to be as short a time as possible in wet clothes and missing as few meals as he could. It has been his habit to "live off the country and to go light," therefore he never carried any camp equipments. His food was of the simplest, being the same as that of the voyageur, with fish and game when it was to be had and with no alcoholic drinks.

Dr. Bell is of a very quiet and retiring disposition and has kept himself so much in the background that few know of the vast extent of his work. He has been the means of immense areas being mapped and divided into territories and provinces, and when we try to realise the greatness of Canada, the sizes of the rivers, lakes and plains which have been surveyed by him, the extent of land which this one man has journeyed over, we are amazed at the greatness of the work accomplished. He has published about 190 reports on various scientific subjects, but, except for short accounts like that written by Mr. Hallock, no record has been published of all his explorations, for, although often asked, Dr. Bell has never given a detailed account of his travels or attempted to extend and publish his own notes, probably owing to pressure of work and his natural reticence.

We are very grateful to Mr. Hallock for giving us an insight into what Dr. Bell has done, and wish Dr. Bell much success in his position as director of the Canadian Geological Survey.

SIR COURTENAY BOYLE, K.C.B.

BY the death of Sir Courtenay Boyle, K.C.B., which took place very suddenly on Sunday last, the country has lost a distinguished public servant and science a very warm friend and powerful supporter.

He was born in 1845, and educated at Charterhouse and Christ Church. At Oxford he became a noted cricketer, playing for the University from 1865 to 1867. In 1868 he began his official life as private secretary to Lord Spencer, then Viceroy of Ireland, an office which he held a second time from 1868–1873. After serving for twelve years as a Local Government Board inspector, in 1886 he entered the Board of Trade as assistant secretary in the Railway Department, in succession to Sir H. Calcraft, who had become permanent secretary to the Board. In 1893, when Sir H. Calcraft retired, Sir Courtenay Boyle, who a year previously had been made K.C.B., succeeded him as permanent secretary. For the past fifteen years he was intimately connected with legislation of the most important character. As assistant secretary he was responsible, along with Lord Balfour, for revising the rates and charges of the railway companies of the United Kingdom. The consolidation of the statutes relating to merchant shipping was his work, and he had much to do with the Conciliation Act of 1896.

But it was in connection with legislation to regulate the supply of electricity for light and power that he was first brought closely into relation with physical science. The position of the electric industries has changed enormously since 1886; earlier legislation had, in many respects, been hostile to their growth. Sir Courtenay's efforts were all in favour of progress, and even those who think that in some respects the progress might have been greater will admit that the difficulties to be overcome were considerable, and that the permanent secretary was always ready to give any reasonable suggestion a fair and courteous consideration. Those who in 1890-91 served with him on the committee which formulated the legal definitions of the ohm, the ampere and the volt, can testify to his care and skill; he was excellent in the chair, possibly in consequence of the fact that he made no claim to be considered an expert on the subject under discussion, but brought a trained business intellect to bear on the problem of putting into a practical form the results of scientific inquiries.

Nor were his sympathies confined to the applications of science. In the recent somewhat acute controversies respecting the magnetic observatories and electric traction, he made it clear to all that he appreciated the importance of a scientific investigation which for the present does not promise direct practical applications; and the satisfactory solution of the difficulty is due in great measure to his tact and patience.

His connection with the National Physical Laboratory was most close and intimate. He was a member of Lord Rayleigh's Committee, and took part in the discussions which led up to the foundation of the Laboratory. As permanent secretary of the Board of Trade he was an *ex-officio* member of the General Board and Executive Committee; he also served on the Finance Committee and various subcommittees, and at all of these he was a most regular and useful attendant. In Lord Rayleigh's absence he usually acted as chairman, and in that position showed a very thorough grasp of the details of the work.

In the difficult discussions which arose as to the site of the Laboratory, his counsel and support were of the highest value; he gave his time freely to the work he had undertaken, and was always ready to discuss fully with the officers of the Royal Society, or the director, the proper course to follow.

He had formed high hopes of the position which the

Laboratory might take and of its future progress, and he had it in his power greatly to help the realisation of those hopes. His death is a serious blow to the new institution—a blow the consequences of which can with difficulty be repaired. R. T. G.

THE NATIONAL ANTARCTIC EXPEDITION.

WE print below a letter which Prof. Poulton has addressed to the Fellows of the Royal Society in regard to the Antarctic expedition. In it he gives a history of the circumstances which have caused Prof. J. W. Gregory to resign the leadership of the scientific staff. The reason for this, to follow the Professor's words, is that since he left England in February changes have been made in his position in regard to the naval commander of the expedition which deprived him of any guarantee that the scientific work would not be subordinated to naval adventure, "an object admirable in itself, but not the one for which I understood this expedition to be organised." The history of the negotiations before and since the beginning of the present year—the date of the letter in which these words occur—show that when Prof. Gregory accepted the leadership of the scientific work (late in 1899), much stress had been laid on the scientific aspect of the expedition, and that the alterations made since the beginning of the present year have increased the authority of the naval commander.

At a special meeting of the Royal Society in February 1898, when the advantages of an Antarctic expedition were fully discussed, Sir John Murray, in an admirable summary of matters requiring further study, enumerated not only the depth, the deposits and the biology of the South Polar Ocean, but also the meteorology, magnetism, geology, and ice-sheet of the region; and laid special stress on the importance of landing a party to remain over at least one winter in order to study the latter points. Dr. Neumayer, Sir Joseph Hooker, Sir A. Geikie and the Duke of Argyll all enlarged on the importance of one or more of the second group. The same were mentioned by members of the deputation, which Mr. Balfour received in June 1899, and in his reply he acknowledged their importance. It is, therefore, not surprising that Prof. Gregory expected the leader of the scientific staff to be allowed a very free hand, and it certainly seems that the negotiations, described by Prof. Poulton, have tended to deprive him of initiative and to place him more completely under the authority of the naval commander. Yet this expedition will afford a great opportunity not only for geographical discovery, but also for increasing scientific knowledge; and for some most important things in the latter a prolonged stay on land is absolutely necessary. Chief among these, in addition to magnetic work, are the following:—The Antarctic land is covered by an ice-sheet greater than that of Greenland, and certainly not less than even the one which some glacialists assert to have formerly existed in Northern Europe. In that land also, as in no other place, we have a chance of obtaining the key to some curious problems in the zoology and botany, past and present, of other continental masses in the southern hemisphere. For both these problems a prolonged residence is required, and an expert who, like Prof. Gregory, is as familiar with ice and its work as he is with palæontological questions.

We may hope then that those representatives of science on the Joint Antarctic Committee whom Prof. Poulton accuses will be able to demonstrate that he is wrong and Prof. Gregory needlessly apprehensive, that Commander Scott possesses such experience in Polar exploration and has such familiarity with the branches of science which we have mentioned as to warrant a man of Prof. Gregory's age and standing in placing himself absolutely under his orders, and that the *Discovery* is a King's ship in so full and real a sense that such entire subjection, even to signing articles, is imperative. Until their explanation is before us we cannot be expected to express a final opinion on the merits of the dispute, and this we shall no doubt obtain very shortly; for those whom Prof. Poulton has accused of running the risk of subordinating scientific investigation to geographical discovery can hardly afford to let judgment go by default.

To the Fellows of the Royal Society.

THE resignation of the man who is, before all others, fitted to be the Scientific Leader of the National Antarctic Expedition will lead the Fellows of the Society to expect some statement of the causes which have produced a result so disastrous to the interests of science. The following statement gives an account of the efforts which have been made to prevent the injury which has occurred.

In the autumn of 1899 Captain Tizard, F.R.S., and I were appointed as the representatives of the Council of the Royal Society on an Antarctic Executive Committee of four, Sir Clements Markham (Chairman) and Sir R. Vesey Hamilton being the representatives of the Royal Geographical Society's Council. Our functions were defined under various heads in a printed form previously agreed upon. No. 2 instructed us to submit a programme of the Expedition for approval to the Joint Antarctic Committee (consisting of sixteen representatives of each Council), "such a programme to include (*a*) A general plan of the operations of the Expedition, including instructions to the Commander, so far as this can be laid down beforehand. (*b*) The composition of the executive and scientific staff to be employed, the duties, preparation and accommodation for, and pay of, the several members." No. 4 instructed us "To make the appointments of the several members of the executive and scientific staff, subject to the final approval of the Joint Committee." The word "civilian" was nowhere employed. The four members of the Executive Committee were placed on the Joint Committee and all Sub-Committees.

Before the first meeting of the Executive Committee Captain Tizard and I were seen by Prof. Rücker, who informed us that one of the first points which the Council of the Royal Society desired us to raise was the relation in power and status between the Commander and the Scientific Leader. In the German Expedition, which was to start about the same time, the Scientific Director had absolute power, and we were asked to consider the possibility of such an arrangement in the English Expedition.

At one of our first meetings, I think the very first, I raised this question and supported the German arrangement. The other three members, who were all naval experts, convinced me that English law required the Captain to be supreme in all questions relating to the safety of his ship and crew. Since that time I have never disputed this point, but always maintained that the scientific chief should be head of the scientific work of all kinds, including the geographical, and that the captain should be instructed to carry out his wishes so far as they were consistent with the safety of ship and crew.

We then considered the appointment of Scientific Leader and decided to nominate Prof. J. W. Gregory, then of the British Museum of Natural History. In suggesting his name to my colleagues I was influenced by his proved success in organisation and in the management of men in a most difficult expedition (British East Africa in 1893), by the wide grasp of science which enabled him to bring back valuable observations and collections in so many departments. His ice experience in Spitzbergen and Alpine regions was also of the highest importance, together with the fact that his chief subject was Geology, a science which pursued in the Antarctic Continent would almost certainly yield results of especial significance. In addition to all these qualifications Prof. Gregory's wide and varied knowledge of the earth rendered his opinion as to the lines of work which would be most likely to lead to marked success extremely valuable in such an Expedition. No one was more competent to state the probable structure of the Antarctic Continent and its relation to that of the earth. This opinion of Prof. Gregory's qualifications for the position of scientific leader of an Antarctic expedition is I know widely held among British scientific men. In their wide combination and united as they are to tried capacity as a leader they are unique, and an expedition with Prof. Gregory for its scientific chief, with as free a hand as English law would permit, was bound to yield great results.

The Committee deputed me to ask Prof. Gregory if he would consent to be nominated. In doing so I carefully explained that he could not have the full powers of the German scientific leader. He consented to consider the offer favourably, but wished for a more definite statement of his position and powers, and for a programme of the Expedition. Shortly after this he was appointed Professor of Geology at Melbourne, and left England. On the voyage he wrote a long letter to the Executive Committee (dated January 19, 1900), which he posted to me at Port Said. In it he said, "I have heard so many rumours as to what is wanted, that I cannot be sure whether I correctly understand the views and wishes of the Executive Committee: I therefore write mainly for the sake of correction, so that I may avoid any misstatements in communicating with the Council of Melbourne University, when the proposal from the Committee reaches me." The plan drafted by Prof. Gregory in this letter included the provision of a landing party with house, observing huts, dog-stable, &c., and he argued that its organisation should be placed "in the hands of the scientific staff," but that, under any circumstances, the Scientific Leader should have the opportunity of controlling a small independent party on land. This letter was read by all the members of the Executive Committee, and, on June 15, at the close of the meeting, the Secretary despatched a cable to Prof. Gregory containing the information "Your letter of January 19 has been received and approved." As soon as Prof. Gregory received this he sent a decoded copy to Sir Clements Markham, who did not correct it. Indeed, at this period Sir Clements Markham frequently expressed opinions which implied that he contemplated the establishment of a landing party independent of the ship. Prof. Gregory applied for and received from the Council of Melbourne University permission to take the appointment on the lines of his letter of January 19.

Prof. Gregory's name was very warmly received by the Joint Committee and he was appointed Scientific Head on February 14, 1900: the words "Formally appointed, wire when fully able to decide," being cabled to him a few days later by Sir Clements Markham.

Lieutenant Robert F. Scott, Torpedo Lieutenant of H.M.S. *Majestic*, was appointed Commander of the Expedition by the Joint Committee on May 25, 1900.

In June 1900 my attention was called to a statement in the Press describing Prof. Gregory as "Head of the Civilian Scientific Staff." Feeling confident that the word "civilian" was not employed in the resolution accepted by the Joint Committee I wrote to Sir Clements Markham on the subject. In his absence the Secretary replied, "The words 'Head of the Civilian Scientific Staff' are the exact words of the resolution passed by the Joint Committee appointing Prof. Gregory, and I know Sir Clements himself was very anxious to have the word 'civilian' in, so that no difficulty might arise between Prof. Gregory and the Commander of the Expedition, since the Civilians would not be the only scientific men on board." The word "civilian" does certainly occur in the minutes of the meeting. On the other hand, Sir Clements Markham was not present on that occasion (February 14, 1900); the word "civilian" did not occur in the instructions issued to the Executive Committee, and was not used in my letter to Sir Clements (February 15) describing the result of the meeting and asking him to cable. The words I used, "leader of the Scientific Staff," were not commented upon in his reply (February 16), stating that the cable should be sent. The word "civilian" was not used by Dr. W. T. Blanford writing to convey the unanimous recommendation of the Geological Sub Committee that Prof. Gregory should be "chief of the Scientific Staff of the Expedition." Prof. Herdman, who seconded the resolution on February 14, and I who proposed it, both remember the words "Scientific Leader of the Expedition." I have not been able to recover a copy of the notice convening the meeting, in which the agenda were put down. It would, however, have been unreasonable for the Joint Committee to have accepted the word "civilian" when it had no information before it which justified the expectation that naval officers would be lent by the Admiralty.

At the meeting of the British Association at Bradford I explained the situation to Prof. Rücker, who agreed with me that it was full of danger, on account of the reasons alleged for the use of the word "civilian," viz. in order to discriminate between the science under Prof. Gregory and that under the Commander. He agreed with me that the coordination of all the science of the Expedition ought to be in the hands of the scientific chief who had been selected because his reputation was a guarantee that all interests would be properly looked after. Sir Michael Foster, to whom I mentioned the matter at a later date, quite agreed with this opinion, but was unwilling to contest the use of the term "civilian." Furthermore, when I raised the question at a meeting of the Representatives of the Royal Society on the Joint Committee, it appeared that the term was actually preferred by certain influential naval authorities who were present, so that it was impossible to resist it without dividing those who desired to give Prof. Gregory such a measure of freedom of action as he was prepared to accept.

At the meeting (November 20, 1900) of the Joint Committee following the conversations with Prof. Rücker and Sir Michael Foster, a Report from the Executive Committee and Submission and Estimate from Captain Scott were read and received, with certain modifications. I indicated to the Secretaries of the Royal Society, who were sitting opposite to me, that this was a favourable opportunity to raise the question of the powers of the Scientific Director over the whole of the science of the Expedition. They were, however, unwilling to do so, hoping, I believe, that all difficulties would be smoothed away by personal negotiations between Captain Scott and Prof. Gregory, who was expected home in a fortnight.

For nearly two months these negotiations proceeded between Prof. Gregory on the one side and Captain Scott and Sir Clements Markham on the other, and between Sir Clements Markham and me.

The principles held were irreconcilable, and it only remained to appeal to the Joint Committee for a decision.

On January 9, 1901, Prof. Gregory wrote to Prof. Rücker, explaining the failure of the negotiations, and on January 28 he addressed a letter to the Royal Society's Representatives on the Joint Committee, from which I select the following paragraphs:—

"I landed at Liverpool on December 5, and went straight to Dundee to meet Captain Scott, and showed him a copy of my letter of January 19 [1900]. As he returned it to me next day without comment I believed that he understood and accepted the general conditions therein stated. On January 7, in order to settle the exact terms of our mutual relations, I submitted to Captain Scott a draft of the instructions I expected to receive from the Joint Committee, and which I had previously shown to Prof. Poulton. To my surprise Sir Clements Markham and Captain Scott expressed disapproval of these instructions, practically on the ground that there could be only one leader of the Expedition, and that that leader must be Captain Scott.

"My colleagues and myself were characterised as civilian scientific experts, accompanying the expedition to undertake investigations in those branches of science with which the ship's officers were unfamiliar, and it was proposed, that to maintain Captain Scott's complete control, all the scientific men should be required to sign articles.

"According to this theory the position of the scientific staff is accessory and subordinate. The contentions of Sir Clements Markham and Captain Scott would completely alter the position which I was invited to take and which alone I am prepared to accept. Were I to accompany the expedition on those terms there would be no guarantee to prevent the scientific work from being subordinated to naval adventure, an object admirable in itself, but not the one for which I understood this expedition to be organised."

The Executive Committee met on January 30 and drafted instructions on lines approved by Sir Clements Markham. They were opposed by my colleague Captain Tizard, but in my absence through illness were passed by two votes to one.

A few days later the draft instructions were considered by the Royal Society's Representatives, who appointed Sir Joseph Hooker, Sir William Wharton and Sir Archibald Geikie to suggest amendments. They carefully considered the draft and suggested several alterations, the most important of these being the instructions to the commander, (1) not to winter in the ice, (2) to establish between two named points on the coast a landing party with three years' stores, under the control of Prof. Gregory.

The Royal Society's Representatives again met and unanimously approved these amendments, which were submitted together with the draft instructions to the meeting of the Joint Committee on February 8. The Representatives of the Royal Geographical Society objected that they had not had the same opportunity of considering the instructions at a separate meeting, and that the amendments were sprung upon them. The meeting was accordingly adjourned until February 12, the very day before Prof. Gregory sailed. During the prolonged discussion which took place the authorities on magnetism were unanimous in affirming that a station on land was essential in order to obtain the full value of the observations made on the ship. . . .

Sir Clements Markham threatened that the Council of the R.G.S. would not accept the amended instructions, whereupon Sir Michael Foster drew attention to the letter which Sir Clements had written at the time when the Joint Committee was proposed.

The amendments were finally approved by 16 votes to 6, and Sir Archibald Geikie and I were deputed to explain to Prof. Gregory, who was in attendance, that he was to be landed in control of a small party, if a safe and suitable place could be found, and to ask if he would accept these conditions. We reported his consent to the meeting, which was then adjourned for the consideration of other details.

Two of the Representatives of the R.G.S., Sir Anthony Hoskins and Sir Vesey Hamilton, resigned shortly afterwards, explaining that they could not agree with the action of the Committee. The R.G.S. had however the right, which it subsequently exercised, of appointing new members.

At the adjourned meeting, on February 19, the question of the ship wintering was discussed at length. Those who had practical experience of the Antarctic urged us strongly not to take the responsibility of permitting the ship to winter in the ice. Sir Joseph Hooker's statement of the danger was especially impressive, and the meeting decided in accordance with his opinion.

At the same meeting Major L. Darwin proposed to modify the conditions accepted by Prof. Gregory, by adding to them the additional consideration that he should only be landed if the time of the ship should not be too greatly diverted from geographical exploration. I protested strongly against any modification at this stage. Sir Michael Foster opposed me, and, after the close of the meeting, there was a somewhat sharp though friendly expression of conflicting opinions, he maintaining that there should be "give and take," I that we were already pledged to Prof. Gregory, that the arrangement was as it stood a compromise—the minimum Prof. Gregory would accept—by no means the one which scientific men, not belonging to the Navy, would have preferred.

At that meeting Major Darwin did not succeed, but his suggestion in somewhat different words was again brought forward at the next meeting on March 5. Just before the meeting Sir Archibald Geikie told me that he intended to support the proposed changes "in the interests of peace," and that Mr. Teall, and Mr. George Murray, Prof. Gregory's representative, also approved them. Resistance was hopeless; I could only protest against any alteration of the conditions offered and accepted, requesting that my name and the names of those who agreed with me (Mr. J. Y. Buchanan and Captain Tizard) should be recorded.

I wrote to Prof. Gregory a full account of what had happened, carefully explaining that his representative and many of his friends supported the changes, that I had confidence that the proposal was made to enable the Geographical Society to accept the instructions and that it was not intended to prevent and I believed would not prevent his being landed.

In spite of the incorporation of Major Darwin's changes the R.G.S. Council refused to accept the instructions, but addressed a letter signed by their President, dated March 18, to the members of the Joint Committee stating that they were compelled, "as trustees for the money subscribed through their Society and for the funds voted by their Society, to regard the above scientific objects [viz. those to be carried out by a landing party] as subsidiary to the two primary objects of the Expedition—namely, exploration and magnetic observations." In view of the unanimous witness of all experts that the landing party was *essential* for full success in the magnetic work this statement is sufficiently remarkable.

The letter went on to inform us that the President, Sir Leopold McClintock, and Sir George Goldie had interviewed the officers of the Royal Society and had reported to the R.G.S. Council which now suggested that the Joint Committee should recommend a small Committee of six, three to be appointed by each Council, to deal finally with the Instructions. The Council of the R.G.S. agreed to accept the decision of this Committee provided the Council of the Royal Society agreed to do the same.

It has been stated in various directions that the Geographical Society produced new evidence (based upon the experience of Borchgrevink and the intentions of the German leader) which had not been laid before the Joint Committee, and thus induced the officers of the Royal Society to agree to a new Committee. To this it may be replied that these sources of information had been open to the Joint Committe, and that, if anything new had arisen, it was reasonable to refer it to the old Committee rather than to a new one appointed *ad hoc*. Furthermore, the letter of the Royal Geographical Society referred to above clearly indicated that the real intention was to escape from the conditions proposed to and accepted by the scientific leader.

The Joint Committee met on April 26, and was addressed in favour of the course proposed by the R.G.S. Council by Sir George Goldie. Nothing was said which could diminish the conviction that the R.G.S. Council and that of the R.S. in weakly consenting to nominate a fresh Committee had struck a disastrous blow at all future cooperation between scientific bodies in this country.

What reply could the Officers make if they were asked to advise the Council of the Royal Society to cooperate with that of the Royal Geographical Society on any future occasion?

I felt justified in asking what guarantee was there that the Council of the Royal Geographical Society would accept the finding of the Committee of six, when it had refused to accept that of a Committee which included all the officers and almost every expert in Arctic and Antarctic Exploration from both Societies. In reply Sir Michael Foster, in spite of the promise of firmness held out by his attitude on February 12, when Sir Clements Markham threatened that his Council would repudiate the finding of the Joint Committee, maintained that they had only acted within their rights, and that the Royal Society Council claimed the right to do the same if it had not agreed with the decision.

At this point it will be convenient to give a list of the Representatives of the Royal Society on the Joint Antarctic Committee, the Representatives of the Royal Geographical Society being equally significant in relation to the Council of their own Society. They are the President, the Treasurer, the Senior Secretary, the Junior Secretary, Mr. A. Buchan, Mr. J. Y. Buchanan, Captain Creak, Sir J. Evans, Sir A. Geikie, Prof. Herdman, Sir J. D. Hooker, Prof. Poulton, Mr. P. L. Sclater, Mr. J. J. H. Teall, Captain Tizard, and Admiral Sir W. J. L. Wharton.

If the reports of Joint Committees of such magnitude and weight are to be thrown over with the approval of the Councils of both Societies because a majority of one Council does not agree with the conclusions, men will rightly hesitate before consenting to devote an immense amount of time and trouble to the work of the Society, and the efficiency of the Royal Society will be greatly diminished.

The considerations set forth above indicate the future injuries which are likely to be inflicted on our Society by this surrender. At the meeting on April 26 I was more concerned with the immediate and pressing injury, and therefore urged that the Royal Society was a trustee for the interests of science and that we had pledged ourselves to secure certain powers to the Scientific Director, that it was better the Expedition should not start (a contingency contemplated as possible by Sir George Goldie, but not a serious danger, I believe, even though the Royal Society had stood firm and appealed to the Government, not on the subject-matter in dispute, but on the refusal of the Royal Geographical Society to work with the recognised methods of cooperation) than that the Royal Society should betray its trust, that the Fellows of the Society would not support the Officers in thus yielding to the Royal Geographical Society, and that I should feel bound to explain my position to the Society. Sir Archibald Geikie and Mr. J. Y. Buchanan also strongly objected to the surrender, which was then confirmed by a large majority of those present.

We were told by Sir George Goldie that the three Representatives of the Royal Geographical Society on the new Committee would be Sir Leopold McClintock, Mr. Mackenzie, and Sir George himself; by Sir Michael Foster that the Royal Society Council would appoint three non-experts, viz. Lord Lister, Lord Lindley and the Treasurer, who could pronounce without bias upon the whole of the evidence. My colleague, Captain Tizard, with whom I had worked with the most complete sympathy and agreement through the whole course of the negotiations, supported the formation of the new Committee because of Sir Michael's assurance that all evidence would be sifted and because of his faith in the validity of the evidence he had to give. Others probably voted in the affirmative for the same reason.

Without asking for evidence from Sir Joseph Hooker, Sir W. Wharton, Sir George Nares, Sir A. Geikie, Captain Creak, Captain Tizard, or Mr. Buchanan, the new Committee proceeded to cable to Melbourne the modifications which have led Prof. Gregory to resign.

In bringing a condensed account of the negotiations before the Fellows of the Royal Society I desire to call attention to certain special difficulties which the Society has had to encounter in the struggle.

(1) The fact that nearly the whole of the money voluntarily subscribed was obtained through members of the Geographical Society and from its funds.

(2) The fact that Sir Clements Markham, President of the Royal Geographical Society, a man of remarkable energy, resource and resolution, was the chief antagonist of the amendments passed by the Joint Committee.

(3) The fact that the Junior Secretary and Sir John Evans were absent from England during the most critical period.

(4) Prof. Gregory's appointment to the Chair at Melbourne, involving his absence from England during a large part of the negotiations.

Making all allowance for these difficulties, I believe that the majority of the Fellows will consider that the claims of the Scientific Chief in an Expedition undertaken to do scientific work have not received from the Royal Society that unflinching, undivided and resolute support which they would have expected and desired. EDWARD B. POULTON.

Oxford, May 15.

NOTES.

We understand that the council of the Society of Arts has awarded the Albert Medal for the present year to the King, and that His Majesty has graciously consented to accept the award. The grounds of the award are principally the services the King has rendered to the Society, and through it to the arts, manufactures and commerce of the country, by acting as its president for thirty-eight years; but reference is also made to the active interest he has long taken in international exhibitions and the actual work which he did as president of the British Commission for several foreign exhibitions, and also as president of the series of exhibitions held at South Kensington, the last of which was the Indian and Colonial Exhibition.

Dr. Laveran, the French surgeon who first investigated the peculiar micro-organisms in the red blood corpuscles of malarious patients, has been elected a member of the Paris Academy of Sciences.

The Report of the Royal Commission upon the British exhibits at the Paris International Exhibition last year has been presented to the King, and some of the observations in it will have to be given serious consideration before the country is represented at any future exhibition of the same character. Indifference to progress abroad and want of combination among manufacturers are two reasons given for the comparatively poor display of British exhibits. It is pointed out that our position has changed since the earlier exhibitions; for foreign industries have made gigantic strides, and in many branches of manufacture have become formidable rivals to our own in the markets of the world. On this account the industrial interests of the country as a whole gain nothing from an exhibition unless they are represented upon equal terms with foreign industries. "We are of opinion," reports the Commission, "that the voluntary system can no longer be relied upon to secure an adequate representation of British industry, and that in any future international exhibition in which it may be decided to take part, it will be necessary to have recourse to the principle of selection, which has been largely adopted by foreign Powers. . . . The contrast between the orderly, symmetrical appearance of the foreign spaces in certain groups with the undignified collection of show cases of different sizes and design which filled the British space was little less than painful." Commenting upon the causes of this conspicuous defect, the Commission says:— "As a rule a British manufacturer will only exhibit if he can select his own goods and display them in his own way and in his own show-case. He is impatient of advice; he will not submit to dictation; he will not share his show-case with others; nor will he join with others to adopt a uniform plan of arrangement. For this reason it is exceedingly difficult to organise collective exhibits. We were strongly impressed from the beginning with the advantages which such exhibits possess. They save space, they avoid the duplication of similar objects, and, in the case of many industries, they ensure a higher level of excellence than any single firm can hope to attain. We endeavoured to persuade exhibitors to adopt the principle, but our efforts met with so little success that we had to abandon the attempt." This is another example of the want of enterprise among British manufacturers, and the narrow spirit in which our commercial affairs are managed. There can be little hope of national progress until broader views are taken of our industrial responsibilities.

This week we have the announcement of what may be safely called the most munificent gift of our time by a private individual to the cause of education in this country. Mr. Andrew Carnegie, the American millionaire, has come forward with a proposal to provide free University education to the youth, both male and female, of Scotland, and offers to place the sum of two millions of pounds in the hands of trustees who shall be charged with the duty of making payment to the Universities of Scotland of the fees of students of Scottish birth. There can be but one opinion regarding the large-heartedness which prompts so magnificent a benefaction, and the whole nation will hope that a sound result may be obtained through so noble a gift. Its terms have as yet been too baldly stated to justify critical analysis of its probable effect, but touching, as it does profoundly, the educational system of the country, the form it will ultimately take is a matter of the utmost moment. Two obvious criticisms evoked by the bare statement that has been made public may, without detracting from the generous intention of the donor, be noted. In the first place, the consequence of the gift as adumbrated must be that secondary education will, in Scotland, alone be unendowed. The gift would be a step towards the realisation of the dream, many times dreamed of old, of education free from bottom to top. This may or may not be a sound policy, but it demands discussion upon its merits and apart from the compulsion of the gift of an individual. What is in Scotland to-day will be required in England to-morrow. Secondly, the gift is no endowment of the Scottish Universities, but it may, on the contrary, be an embarrassment to them. It means the creation of some sixteen hundred bursaries, each of the value of nine pounds, in each of the Universities. This will not bring an influx of sixteen hundred students to each University, but, if Mr. Carnegie's intention be realised, we take it there will be a considerable increase in the number—sufficient, indeed, to swamp the existing equipment for teaching, for the strengthening of which their fees may be inadequate. Whilst it is earnestly to be wished that this large sum of money may be secured to the cause of education, it is to be hoped that those with whom Mr. Carnegie may take counsel will use their influence to harmonise his evident intention to benefit the masses with the real educational needs of the country and with the work of the Universities.

THE anniversary meeting of the Royal Geographical Society was held on Monday, when the president, Sir Clements Markham, K.C.B., distributed the medals and prizes for the encouragement of geographical science and discovery. The founder's medal was awarded to the Duke of the Abruzzi for his expedition to Mount St. Elias in North-West America, and towards the North Pole by the Franz Josef Land route. The patron's medal was awarded to Dr. A. Donaldson Smith, for his African explorations and surveys. Other awards were the Murchison award for 1901 to Mr. John Coles, for his services to geography and to the Society as map curator and instructor during a period of twenty-two years. The Gill memorial for 1901 to Captain Cagni, for his journey over the frozen ocean to latitude 86° 33′ N. The Back grant for 1901 to Sub-Lieutenant W. Colbeck, R.N.R., for the survey work which he did in Victoria Land, and during the voyage of the *Southern Cross*. The Cuthbert Peek grant for 1901 to Mr. L. C. Bernacchi, for his series of scientific observations taken in Victoria Land and the Ross Sea. After the presentation of the medals the president delivered an address, in the course of which he referred to the recent international conference in Christiania for the exploration of the ocean, and to the equipment and the arrangements connected with the National Antarctic Expedition. After mentioning the matters dealt with in another column and sketching the programme of work to be done by the expedition, the president said it was necessary that there should be a second ship ready to proceed south in November, 1902, in the possible contingency of any accident or of the detention of the *Discovery*. It was also very desirable that there should be sufficient funds for a third year. But the first of these objects was essential. A whaler might be bought or hired, and she would have to be manned and provisioned. The cost would be about 15,000*l*., towards which amount 5000*l*. had been promised by one donor and 500*l*. by another.

The annual conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, South Kensington, on Friday, June 14.

MR. R. W. DANA has been appointed secretary to the Institution of Naval Architects, to succeed Mr. G. Holmes, who has accepted a position under Government.

AT the annual meeting of the African Trade Section of the Liverpool Chamber of Commerce held on Monday, Mr. Alfred L. Jones, the president, remarked that all West African people had lent themselves heartily to support the great effort of the Liverpool School of Tropical Medicine, which the Chamber of Commerce initiated. Mr. Chamberlain has written a letter in which he expresses pleasure "that through the generosity of a Glasgow citizen, and by the action of Major Ross, who is prepared to give his services without remuneration, the Liverpool School of Tropical Medicines has been able to arrange that Major Ross should proceed to West Africa for the purpose of endeavouring to effect the extermination of the Anopheles mosquito in a selected town. It is understood that Major Ross proposes to select a town for the experiment either in Sierra Leone or the Gold Coast, and the Governors of these colonies have been requested to afford him all the assistance in their power."

AT the Royal Institution to-day Prof. Dewar will deliver the first of a course of three lectures on "The Chemistry of Carbon." On Tuesday, May 28, Prof. William Knight will begin a course of two lectures on "The Philosophical Undertones of Modern Poetry" (the Tyndall Lectures), and on Saturday, June 1, Prof. J. B. Farmer will deliver the first of three lectures on "The Biological Characters of Epiphytic Plants." The Friday evening discourse on May 24 will be delivered by Mr. R. T. Glazebrook, on "The Aims of the National Physical Laboratory," on May 31 by Mr. A. H. Savage Landor, on "With the Allies in China," and on June 7 by Prof. R. Meldola, on "Mimetic Insects."

THE *Times* announces the death, at St. Petersburg, of Dr. E. Bretschneider, one of the most distinguished students of Chinese history and knowledge of his time. For many years Dr. Bretschneider was physician to the Russian Legation at Peking, and took advantage of his exceptional position to devote himself to the investigation of Chinese archæology, history, language, geography, &c. One of his latest works is a "History of European Botanical Discoveries in China," and another one of the best maps of China available, both of them in English. Among other works from his pen are the following:—"On the Study and Value of Chinese Botanical Works"; "Fu-sang, or Who Discovered China"; "On the Knowledge possessed by the ancient Chinese of the Arabs and Arabian Colonies"; "Notes on Chinese Mediæval Travellers to the West"; "Archæological and Historical Researches in Peking and its Environs"; "Mediæval Researches from Eastern Asiatic Sources." Dr. Bretschneider was an honorary corresponding member of the Royal Geographical Society, as well as of many other societies.

As already announced, the sixth annual congress of the South-Eastern Union of Scientific Societies will be held at Haslemere and Hindhead on June 6–8. An address will be given by the president-elect, Mr. G. A. Boulenger, F.R.S., and a number of interesting papers are down for reading, among them being the following:—Moisture in the atmosphere, the Hon. Rollo Russell; certain aspects of post-Darwinian work in zoology, Prof. G. B. Howes, F.R.S.; seedlings, Miss E. Sargent; the teaching of nature knowledge in elementary schools, Miss A. M. Buckton and Prof. A. D. Hall; habit and discipline in their influence on organisation, Dr. Jonathan Hutchinson, F.R.S.; an eclipse trip to Portugal in 1900, Mr. G. F. Chambers; cuckoos' eggs, Mr. Oswald H. Latter; and the origin of certain weeds, Mr. S. T. Dunn.

PROF. H. H. GIGLIOLI, of the Royal Zoological Museum, Florence, informs us that on April 13 the second annual meeting of the Zoological Union of Italy concluded its work at Naples. This Union was formed at Pavia last year and in the following September it held its first general meeting at Bologna, which proved to be quite a success as to the work performed and the large attendance. It became evident that the Union, the scope of which is to collect the scattered forces of students of zoology and to prepare the way for the foundation of a zoological journal worthy of Italian science, has responded to a wish generally felt in Italy. The Union now counts amongst its members nearly all the Italian professors of zoology and anatomy and many other students of those sciences. The meeting at Naples was even more numerous than that at Bologna, and many interesting communications were read. Bologna greeted the assembled zoologists with the memories of its old masters—Aldrovandi, Malpighi, Alessandrini and others; at Naples they were *fêted* by that great centre of zoological investigations, the Zoological Station, whose steam-launch, which bears the glorious name of *Johannes Müller*, gave the visitors practical examples of pelagic trawling and dredging, as the war steamer *Ercole* bore them to Capri. Rome has been chosen for the third congress, in 1902, "when," remarks Prof. Giglioli, "we shall be proud and happy to welcome any of our foreign colleagues who should choose to honour us with their presence."

WE are indebted to the president of the International Aëronautical Committee for the following preliminary results of the balloon ascents on April 19. The number of balloons was 19, of which 6 were manned, and the countries that participated in the investigation were Austria, France, Germany and Russia. The results of the manned ascents from Berlin and Vienna were remarkably coincident: Berlin, temperature at starting, 5°·6 C., and −25°·5 at an altitude of 5500 metres; Vienna, 5°·0 at starting, and −25°·0 at 5260 metres. The greatest heights attained by the unmanned balloons were: 10,500 metres at Strassburg, temperature −54°; 11,100 m. at Trappes (near Paris), temperature −62°; 11,848 m. at Chalais-Meudon, temperature −52°·8 C. The only instance in which an inversion of temperature was recorded appears to have been at Strassburg, but the balloon, which was made of paper, burst at an altitude of 1500 metres.

A GENERALISATION of Clairant's form in the theory of differential equations of the first order, based on certain considerations given by Raffy, is contained in a note by Signor Minea Chini in the *Rendiconto* del R. Istituto Lombardo, xxxiv. 8. In this note the author examines what are the types of differential equations of the first order in x, y whose general integrals are obtainable by replacing the differential coefficient p in the original differential equation by a previously determined function, (i.) of x, C, (ii.) of x, y, C, where C is an arbitrary constant.

A SHORT note on the propagation of *Filaria immites* by the agency of mosquito bites is contributed by Signor G. Noè to the *Atti* dei Lincei, x. 8. It has now been conclusively proved that the filariæ of the blood are transmitted from one host to another by mosquitoes which act as intermediate hosts. An experiment, in which a healthy dog was made to eat hundreds of Anopheles, both from infected regions and others infected in a laboratory, without itself becoming infected, excludes the possibility of the parasites being propagated otherwise than by punctures.

THE *Transactions and Annual Report* of the Manchester Microscopical Society for 1900 bears ample testimony to the flourishing state of that institution and the keenness of its members for hard work. The address of the president, Prof. S. J. Hickson, deals with the reproduction and life-history of the Protozoa, special attention being directed to recent investigations on that group and the alteration in our views thereby rendered necessary. It is now inexact to say that the Protozoa are, as a general rule, animals of simple constitution, many of them being, to a certain extent, specialised. Among other papers, Mr. M. L. Sykes contributes an exceedingly interesting article on smallpox and vaccination, and the mode of producing glycerine cultivations of vaccine lymph, which may be commended to the best attention of anti-vaccinationists.

THE two issues (Nos. 9 and 10) of the *Biologisches Centralblatt* for May contain articles dealing with the freshwater invertebrate fauna of Lake Baikal. In No. 9 Herr W. Zygoff discusses the sabellarian annelid from the lake described by Prof. J. Nusbaum in the same journal for January 1 as the first known freshwater member of its group under the name of *Dybowscella baicalensis*. It is pointed out that a North American freshwater form, *Manayunkia speciosa*, was described long ago by Leidy, and it is urged that the one inhabiting Lake Baikal is inseparable. In the following article Prof. Nusbaum disputes this identification, alleging that while Manayunkia is hermaphrodite, in Dybowscella the sexes are distinct. No. 10 contains a general article on the fauna of the lake by Herr A. Korotneff, in which a new freshwater polyzoan is described as *Echinella placoides*.

UNDER the title of "A Theory of the Origin and Evolution of the Australian Marsupials" Mr. B. A. Bensley, in the April number of the *American Naturalist*, publishes a further account of the result of his investigations into the history of that group. Starting with the well-known fact that the group simulates most of the placental orders, the inference is drawn that its evolution or "radiation," has taken place within its present habitat. Reasons are then given for regarding the banded anteater (Myrmecobius) as a degraded type; and if this view be accepted, all the other types can be derived, both as regards their dentition and their feet, from the American opossums, the ancestors of which are regarded as the progenitors of the whole group. All the Australian marsupials thus appear to have had an arboreal ancestry; and when, in spite of the specialisation of certain forms, the primitive character of the whole group is borne in mind, it seems evident that the date of the "radiation" is comparatively recent. Hence the author is inclined to side with those who consider that marsupials first entered Australia during the Tertiary period, although he thinks their arrival was later than has previously been considered possible. As to whether their immigration was from the north or from the south he is undecided, although he states that "there is at least some justification for the view that it was from the northward," *i.e.* by way of Asia.

DURING his travels in Southern India (1816–20), with a view to the economic development of Pondicherry and other French possessions in the East, Leschenault de la Tour made a valuable collection of rocks, which are preserved in the Museum of Natural History in Paris. Some of the rocks, pyroxenic and scapolitic gneisses, were described in 1889 by Prof. A. Lacroix, but as their geological relations had not been determined, Mr. T. H. Holland, of the Geological Survey of India, has specially examined the entire collection in Paris, and has also investigated the area from which the rocks were obtained. His observations are recorded in an article on the geology of Salem, Madras Presidency (*Mem. Geol. Surv. India*, vol. xxx. part 2, 1900). The rocks which he describes are, in probable order of age, (1) fundamental biotite-gneisses; (2) schists; (3) pyroxene-granulites; and (4) younger igneous intrusions, including basic dykes, peridotites and "white elephant" rocks—masses of quartz having the characters of plutonic quartz and containing much liquid carbonic acid.

IN the May issue of the *Cambrian Natural Observer*, Mr. Arthur Mee directs attention to the state of the grave of the Rev. T. W. Webb, author of the classical "Celestial Objects for Common Telescopes," in the churchyard of Mitchel Troy, near Monmouth. There is no reference on the stone to indicate the invaluable work accomplished by Webb, and Mr. Mee suggests that some means be adopted of suitably recording the services rendered to astronomy by the deceased divine.

THE peculiar thermal properties of the alloys of nickel and steel discovered by M. C. E. Guillaume have already met with more than one application, the existence of an alloy with a practically negligible coefficient of expansion pointing to an ideal material for the construction of length standards for geodesic measurements. In the current number of the *Comptes rendus* is described a further application by M. Guillaume of this material. The secondary compensation error of a chronometer, discovered by Dent in 1833, is due to the fact that a chronometer adjusted for two fixed temperatures is not perfectly adjusted for any other temperature. In the present paper, it is shown that by the use of a suitable nickel-steel alloy it is possible to compensate perfectly the variations of elasticity of the spring with a balance of the ordinary form.

THE same number of the *Comptes rendus* contains an important communication by M. Jean Friedel to the theory of chlorophyll assimilation. It is usually held that three conditions are necessary for the assimilation of carbon—the presence of chlorophyll, the existence of living protoplasm in contact with the chlorophyll, and light rays. The results of the experiments described in the present paper would appear to show that the second condition is not essential. A glycerine extract of the leaves, filtered first through paper and then through a Chamberland porcelain filter, and containing no trace of cells or even of protoplasmic débris, shows no assimilation in either light or darkness. The leaves of the same species dried at 100° C. gave a green powder containing no living matter, an extract also showing no assimilating power in the light. But a mixture of these two extracts exposed to the light readily absorbed carbon dioxide and gave off oxygen. From these experiments the author concludes that chlorophyll assimilation is accomplished without the intervention of living matter by a diastase which utilises the energy of the sun's rays, the chlorophyll acting as a sensitiser.

THE additions to the Zoological Society's Gardens during the past week include a Red Howler (*Mycetes seniculus*) from Colombia, presented by Commander A. Jolliffe; an Arctic Fox (*Canis lagopus*) from the Arctic Regions, presented by Dr. H. A. Allbutt; a Black-faced Kangaroo (*Macropus melanops*, ♀) from Tasmania, presented by Miss Amy Mitchell; two Barred Doves (*Geopelia striata*) from India, presented by Mr. W. A. D. Harding; an Allen's Porphyrio (*Hydrornia alleni*), captured at sea, presented by Miss V. I. Nielsen; a Rook (*Corvus frugilegus*), British, presented by Mr. A. Yates; a Spider Monkey (*Ateles*, sp. inc.), a Kinkajou (*Cercoleptes caudivolvulus*), a Feline Douroucouli (*Nyctipithecus vociferans*), a Corais Snake (*Coluber corais*) from South America, a Vulpine Phalanger (*Trichosurus vulpecula*), a Short-tailed Wallaby (*Macropus brachyurus*), two Quoy's Lizards (*Lygosoma quoyi*) from Australia, an —— Ibex (*Capra*, sp. inc.) from Persia, two Simony's Lizards (*Lacerta simonyi*) from the Canaries, six Tigrine Frogs (*Rana tigrina*) from the East Indies, three Schlagintweit's Frogs (*Rana cyanophlyctis*) from Southern Asia, five —— Skinks (*Eumeces skiltonensis*), four Changeable Tree Frogs (*Hyla versicolor*) from North America, a Californian Toad (*Bufo boreas*) from California, two Hamilton's Terrapins (*Damonia hamiltoni*), four Bungoma River Turtle (*Emyda granosa*) from India, deposited; two Common Teal (*Querquedula crecca*), a Shag *Phalacrocorax graculus*), European, purchased; a Japanese Deer (*Cervus sika*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEW VARIABLE STAR 71 (1901) AURIGÆ.—Mr. Stanley Williams announces in the *Astronomische Nachrichten*, Bd. 155, No. 3708, the discovery of variability in the star B.D. +42°·1295, the position of which is

$$\left.\begin{array}{l}\text{R.A.} = 5\text{h. } 18\text{m. } 19{\cdot}5\text{s}\\ \text{Decl.} = +42^\circ\ 18'{\cdot}5\end{array}\right\}(1855{\cdot}0).$$

The magnitude variations have been measured from photographs taken with a portrait lens of 4·4 inches aperture, and the following are the elements deduced:—

Period, 0·7925d. = 19h. 1m. 12s.
Epoch max. 1901 March 3 (2415447), 13h. 0m. G.M.T.
Limits of variation, 8·75 mag. to 9·65 mag.
Max. to min., 14h. 13m.
Min. to max., 4h. 48m.
Ratio of increase to decrease = 0·34.

SPECTRUM OF ζ PUPPIS.—In *Harvard College Observatory Circular*, No. 55, Prof. E. C. Pickering gives the results of a new investigation by Mr. King of the spectrum of ζ Puppis with relation to the new lines of hydrogen found in that star some time ago. The lines occur also in δ and ε Orionis and the spectra of these stars have consequently been used in the reduction. The first line of the series corresponding to the red ordinary line has not yet been recorded, and the observed series consists of seven lines whose measured wave-lengths were 5413·6, 4542·4, 4200·7, 4026·0, 3924·0, 3860·8, 3815·7.

DEFINITIVE ORBIT OF COMET 1894 II. (GALE).—In the *Astronomical Journal* (vol. xxi. Nos. 496–7), Mr. H. A. Peck brings together all the available published observations of this comet from April to July 1894, and from their discussion computes the definitive elements referred to the mean equinox and ecliptic of 1894·0, which are the following:—

$$\begin{aligned}T &= 1894 \text{ April } 13{\cdot}406912 + 0{\cdot}0003958\nu\\ \omega &= 324^\circ\ 12'\ 22''{\cdot}52 + 1{\cdot}2046\delta\nu\\ \Omega &= 206\ \ 23\ \ 53{\cdot}04\ \ - 0{\cdot}5347\delta\nu\\ i &= \ \ 86\ \ 59\ \ 18{\cdot}19\ \ + 0{\cdot}8478\delta\nu\\ q &= 0{\cdot}9830931 + 0{\cdot}000001339\delta\nu\\ e &= 0{\cdot}9911206 + 0{\cdot}000002837\delta\nu\end{aligned}$$

$\delta\nu$ will most probably have some value between $-20''$ and $-60''$. For $\delta\nu = 40''$ the period of revolution would be 1143 years. The orbit of this comet appears to indicate peculiar relations to that of Jupiter. During the entire period of visibility, and for two or three years previous, the planet was near the orbit plane. A computation of the perturbations due to the major planets is now in progress.

THE UNIVERSITY OF LONDON.

THE presentation of prizes and degrees at the University of London on Wednesday, May 15, was the occasion of some noteworthy remarks upon the work and promise of the University. We give the Vice-Chancellor's address, together with parts of subsequent speeches.

Sir Henry Roscoe said,—"The past year has been one of loss and sorrow not only to the whole nation but also to this University. It has, however, I hope, been a year of some achievement. The death of her late Majesty, Queen Victoria, deprived us not only of our visitor but also of our foundress, and it is no small matter to have such a name to look back upon. For, although the earliest charter of the University bears date 1836, and was amongst the last of those issued by King William IV., yet no real start had been made in the work of the University previous to the accession of the Queen, and at the commencement of her reign she showed her interest by formally renewing the first charter of the University. This early interest never declined and, in 1870, when, after long delay, the University was granted by the Government a home of its own in Burlington-gardens, it was the Queen who personally opened the building on the presentation day of that year.

"The senate and graduates of the University presented a respectful address of condolence and congratulation to His Majesty, King Edward VII, on his accession, and the King in his gracious reply, which I will venture to read to you, was pleased to express his own continued interest in this University. His words were as follows:

"'I thank you for your loyal and dutiful address and for your sympathy with the grief of myself and my family for the death of my beloved mother.

"'The progress of your University, from its commencement almost at the date of her late Majesty's accession to its recent reorganisation as a teaching as well as an examining body, has been one of the most remarkable developments witnessed in a reign memorable for the spread of higher instruction among both sexes and all classes and races in my Empire.

"'You may feel assured of my hearty sympathy and good wishes and cooperation in the furtherance of your good work.'

"It will be in the recollection of many of you that, exactly a year ago to-day, it was the speaker of these words who, as Prince of Wales, sat on the right hand of this chair and spoke words of hope and good augury for the future upon our recent occupation of this newer and larger abode.

"But it is not only the death of the Queen that we have to regret. A most serious illness has, during the last few months —months of critical import for the University—made it impossible for our Chancellor to take any part in our work. He has, you will all be glad to hear, made a marvellous recovery, and he has sent me a letter to read to you from which you will see the deep interest he continues to take in all our affairs. It will be no small pleasure to him to think that, in his absence, we have as our guest his old colleague and friend, Lord Rosebery.

"It has been the lot of our Chancellor for many years past to speak with hope deferred of the creation of a great teaching University in and for the metropolis. This year, if it is not exactly in my power to say that the reconstitution and re-organisation have been completed, yet this one can say, that it will be chiefly ourselves whom we shall have to blame—I mean the teachers, the schools, and even the senate of this University—if a great centre of learning and research does not grow up in London.

"For although, ladies and gentlemen, the old work of the University will be continued in the future as it has been in the past—even, I may hope, with increased prosperity—although the examination of all candidates, no matter what their origin or their means of knowledge, will continue with that absolute fairness and impartiality upon which the University has built up so great a reputation, yet we must not deceive ourselves. The most perfect examinational system conceivable can only, to quote the words of the reply from the throne, add to the 'higher instruction' of a nation. But this is not enough. If we are to meet successfully the constant changes of thought and manner of life to which a highly organised society is increasingly liable, our Universities must not be content with giving instruction or testing attainment, however high, but must make real contribution to the knowledge which alone in some form or other will be a guarantee of the stability of that society. Unless the University of London is known as a centre from which almost daily additions to our understanding of the world of thought and matter emanate, we shall not have justified our existence.

"But, ladies and gentlemen, how is this end to be attained? Such results cannot come from a few weeks' work, or without the expenditure of much energy and money. In the first instance it should be our object to reduce to a minimum the wastage of our forces by overlapping and friction between the various elements of the University already existing. The need for concentration in preliminary medical studies is one of the most urgent of these early steps, not merely—not even chiefly—because it is a waste to have the work in these junior departments spread over London with frequently inefficient or duplicated equipment, but largely because the relief that would come to the medical schools by concentrating these studies in two or three central institutions would place at the disposal of the authorities opportunities and space badly needed for conducting research in pathology, bacteriology and the other higher branches of medical and surgical science.

"Such a concentration, as has been suggested in the case of the Medical Faculty, will doubtless lead to difficult problems which will require, and, I am sure, will receive, the whole-hearted cooperation of the various schools and teaching institutions of the University for their successful solution.

"It will not be necessary, I hope, to remind you that it will be ultimately impossible for each school of the University to fulfil within its four walls all the functions that belong to a university such as we conceive it to be at the present day. There are parts of London in which certain kinds of study can be much more profitably pursued than in others. It would be foolish, for instance, to attempt to centralise the study of ancient literature and archæology in Surrey or even in South Kensington, whereas we have materials around us here without parallel for the study of natural history, or of the history of modern art, to say nothing of pure and applied science. As opportunity arises for the better equipment of this or that branch of learning, it should be our aim to inquire in what part of London this equipment can be placed so as best to make use of facilities already existing and so as best to attract the largest possible number of good students. If this be our policy, our University will in course of years become an Imperial University in an altogether new and fuller sense, and the reputation that it will win for itself in the world of thought will bring it those more solid rewards without the aid of which its successful working will be seriously endangered.

"But without the schools of the University we can do nothing, and I venture to take this, the first, opportunity of calling upon them here—to-day—to take their share in this movement and to believe that the best hope of success for each member of the body corporate will be found in the prosperity of the whole."

Lord Rosebery said, in the course of his remarks, "In my judgment the struggle of this coming century will not be so much one of brute force as of trained intelligence. In the diplomacy of the world, in the markets of the world, in your arrangements of legislation and of government, it will be intelligence that will win. There was a time, I do not doubt, not so long ago, when the nations of the world were satisfied with a very moderate degree of instruction and intelligence. The schoolmaster, we are told, was abroad—I think it was said by Lord Brougham and probably in this University—and he has been so much abroad that no nations are satisfied with the standard of education that prevailed 25 years ago. Every nation demands a more keen and more trained and, if I may use the adjective, a more versatile intelligence than that which was adequate for the business methods of the Empire in former days. In other words, we have to meet much keener competition in every department of life. I hope, though perhaps not with much confidence, that all our educational institutions in this country are recognising that fact, or are about to, and are preparing to furbish up their somewhat antiquated methods in some cases to meet the demands of modern civilisation and modern competition. That is what this University has done, and is doing; and that is why I am so happy to be here to-day and to give my modest and unasked for benediction to these proceedings."

Sir Michael Foster held that there must be in London a University devoted, not only to the spreading of knowledge, but also to the making of knowledge.

Lord Reay said that London could offer facilities for research in every domain second to none in the civilised world. They might look forward to an increasing number of students from every part of the Empire to make use of those resources. Modern requirements were constantly growing, and they could not cope with the demands made on them without the exercise of public spirit which was so brilliant in the United States of America.

THE LANGUAGE AND ORIGIN OF THE BASQUES.

THE Basques or Euskaldunak (*i.e.* "the Men"), as they call themselves, are a most remarkable people who have long been an interesting problem to ethnologists. The most anomalous point about the Basques is their language, which is as typically agglutinative as any Asiatic or American tongue. Ripley, in his fine book "The Races of Europe," points out that the verb habitually includes all pronouns, adverbs and other allied parts of speech; as an example of the appalling complexity possible as a result, Bladé gives fifty forms in the third person singular of the present indicative of the regular verb "to give" alone. Another often quoted example of the effect of such agglutination occurs in a reputed Basque word meaning "the lower field of the high hill of Azpicuelta," which runs,

Azpilcuelagaraycosaroyarenberecolarrea.

No wonder that the French peasants state that the devil studied the Basque language for seven years and learned only two words. Like many other undeveloped languages, the principle of abstraction or generalisation is but slightly developed; for example, as there is no general word for "sister" the Basques have to say "sister of the man" or "sister of the woman," &c. Owing to their isolation on both flanks of the Pyrenees, many primitive institutions persist among the Basques. In some places the eldest daughter takes precedence over all the sons in inheritance, which may be a relic of a former matriarchal family; communal ownership within the family is frequently practised. The remarkable custom now known as the couvade, in which the father takes to his bed on the birth of a child, was attributed to these people by Strabo, and it is believed by some not to have completely died out at the present day, though there is great difficulty in proving its existence, as G. Buschan points out in *Globus* (Bd. lxxix. p. 117). H. Schuchardt has recently (*Globus*, Bd. lxxix. p. 208) expressed his wonder that this statement has again been dragged from the realm of fable. The same writer makes some remarks on misapprehensions respecting the Basque language.

Many wild theories have been promulgated as to the origin of the Basques, one of the most absurd being an attempt to relate them with a certain tribe in Central America. Several scholars have sought to affiliate the people with Lapps and Finns, and they have been supposed to be related to the ancient Egyptians, the ancient Phœnicians, the extinct Etruscans and to the Picts. The Basque language appears to be absolutely without connection with any of the so-called Turanian (Ural-Altaic) languages, since, as Keane shows in his "Man Past and Present" (p. 460), there is no longer any doubt as to the relationship of the Basque with the Berber language.

The anthropometrical evidence has given rise to much controversy. The French Basques have an average cephalic index (on the living) of 83, while the Spanish Basques average 78, according to Collignon, and 79 according to de Aranzadi in the graphic curve published by the latter anthropologist, who, by the bye, is himself a Basque; there are two distinct maxima, one at 76 and the other at 80, indicating, probably, that there are at least two elements in the group. The French Basques are on an average three-quarters of an inch shorter than their Spanish brethren, 1657 mm. (5ft. 5¼ins.) and 1638 mm. (5ft. 4½ins.) respectively. Both branches of the stock have a similar very characteristic head; the cranium is distinctly long even in the most brachycephalic subjects, and is enormously swollen in the temporal region, a character which is absolutely peculiar to this people, the forehead is high and straight and narrow below, the face is very elongated and has the shape of an inverted triangle, the chin being thin and pointed; the nose is correspondingly long and narrow.

Certain anthropologists have claimed that those Basques who live north of the Pyrenees more nearly represent the primitive stock, while the same has been asserted for those south of that range. De Aranzadi thinks that those Spanish Basques with dark hair and eyes and a rather narrow head and of middle stature are of true Iberian origin and are related to the Berbers. Those with darkish brown hair and greenish hazel eyes, a broad head and low stature are, according to him, of Ugrian or Finnish descent. G. Buschan, in a recent number of *Globus* (Bd. lxxix. p. 123), regards it as highly probable that the Basque race resulted from a crossing of the short-heads of the earliest prehistoric time, who probably wandered from Asia into Europe, with the long-headed indigenous Mediterranean race. The first of these two constituents he recognises as the race of Grenelle (French authors) or as the type of Sion or Disentis (His-Rütimeyer) or as the celts of Broca. Buschan has overlooked the fact that Canon Isaac Taylor, in his "Origin of the Aryans," had suggested this same explanation in 1890 and Beddoe had alluded to it in his "Anthropological History of Europe" in 1893. De Aranzadi recognises a third element with light hair, blue eyes, narrow head and tall stature, which is a later addition of Kymric or Germanic origin, and he suggests that this element is related to the accursed race of the Cagots who were isolated from their neighbours and had a separate church door for themselves.

Collignon, who has made many brilliant studies in the anthropology of France, draws attention to the very anomalous relation that exists between a cephalic index of 82·5, which is clearly brachycephalic, and a cranial length as great as 191 mm. He is of opinion that this permits us to look for the affinities of the Basque race more in the direction of the long-headed races; the Nordic, or Teutonic, being clearly out of the question, relationship must be sought among the Mediterranean group of peoples rather than in the direction of the brachycephals of France and of Central Europe. Collignon's view is that the Basque type is a variety of the Mediterranean race that has for a long period of time been geographically isolated, and the retention of a difficult and uncouth language has formed an equally efficient linguistic barrier. These factors induced in- and in-breeding, and a well-marked human variety has resulted. Collignon's contention that the French Basques more nearly represent the primitive stock is now generally admitted; the head of the Spanish Basques has been narrowed and their stature diminished by mixture with Spaniards who had been driven into the mountains by the Moorish invasion. Those who desire to learn more about this paradoxical people will find numerous references to the literature in the valuable appendix to Ripley's "Races of Europe," and additional titles are given by Buschan in *Globus* (Bd. lxxix. February 28, 1901).

A. C. H.

THE DIAGNOSIS OF PLAGUE.[1]

I HAVE no doubt that the plague expert, who has seen epidemic plague in the East, will think it unnecessary on the part of a bacteriologist to ask, What is plague? for is not plague, as it occurs in China, India, at the Cape, and other parts weekly, nay, daily, by the score of cases, quite readily diagnosed by its clinical features and by its pathology? No one can have any doubt about this being so; that is to say, when plague appears in a locality in epidemic form, the diagnosis of any new case does not offer much difficulty; nor would there be experienced much difficulty in diagnosis by etiological, clinical, pathological and bacteriological methods of a case, or of cases, occurring in a ship coming from a plague-infected port: as, for instance, the cases that occurred in connection with a vessel which arrived about the middle of January in the port of Hull—cases which belonged to the pneumonic type, and which from the outset were, or ought to have been, at once diagnosed as such.

The difficulty in diagnosis commences when you have a single or a first case occurring, where either the etiological data are not satisfactory, or where the clinical history and symptoms are not distinct and not typical. The cases of two sailors recently examined illustrate these two difficulties.

The outcome of the bacteriological analysis of one sailor who arrived in London in October 1900 was that the case was plague. In the second case a plate made with a small droplet of pus from a swelling yielded, besides staphylococci and streptococci, a considerable number of colonies of the *bacillus pestis*. Tests by subcultures and animal experiments (both as subcutaneous and intra-peritoneal injections) proved this conclusively.

A third case is that of a boy that had recently occurred in one of the London hospitals. This much is certain, that the boy suffered from an illness the symptoms of which to a large degree were compatible with true plague; that etiologically no satisfactory evidence was forthcoming to elucidate the disease. The bacterioscopic evidence, which in certain respects supported the diagnosis plague, in another essential respect—animal experiment—negatived it; and I would particularly draw attention to the total absence of any microbes in the pus of the suppurating bubo of the boy in the later stages of his disease, and to the total absence of agglutinating action of his blood in the convalescent stage.

Apart from the difficulties in diagnosis of isolated cases, there are to be gathered, I think, several interesting and instructive facts from the cases hitherto mentioned.

In the first place, it is a fact that neither of the ship-borne cases mentioned above gave rise to infection in other persons, although during the whole journey they were freely intercommunicating with other members of the ship's crews. It will be no doubt said that *pestis ambulans*, the mild form with which, at any rate, one of those two cases compares, is known to possess only slight infectivity, and this infectivity might be referable only to the matter of the open and discharging bubo. In the two cases mentioned the number of *bacilli pestis* were still considerable, and in one at least of the cases there was a history of severe illness previous to arrival in English ports. And I would, in this connection, express a *primâ facie* strong scepticism as to the alleged high degree of infectivity of the bubonic type of plague in general. In the case of the pneumonic and septicæmic type, a high degree of infectivity is in complete accordance with the bacteriological facts and with the wide distribution of the plague bacilli in, and the copious discharge from, the body of the patient. In the pneumonic type, the exudation of the inflamed lung and the expectoration teem with the plague bacilli; in the septicæmic or hæmorrhagic form the blood contains an abundance of the bacilli, hæmorrhages occur in the membranes of the alimentary, respiratory and urinary organs; and therefore the voiding of plague bacilli is extremely great and their diffusion easy. But in the bubonic form, in the early phases of the disease, plague bacilli are rare in the blood; they are practically limited to the spleen and lymph glands, and as long as these latter do not open I do not see how they can be the agents of further infection. In the urine and in the alimentary canal they certainly cannot be demonstrated in a living state in this form of the disease. When the lymph glands, after the acute stage is passed, suppurate and open, then, no doubt, plague bacilli can and do become available.

[1] Abstract of a paper read before the Epidemiological Society on Friday, May 17, by Dr. E. Klein, F.R.S.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Dr. W. T. Brooks has been appointed Litchfield clinical lecturer in medicine.

Prof. H. A. Miers has been nominated to be a delegate of the University Press.

Mr. P. A. Barnett has been appointed an examiner in the theory, history and practice of education.

Profs. H. A. Miers and W. F. R. Weldon have been appointed examiners for the Burdett-Coutts Scholarship.

The Report of the Bodleian Library, just issued, shows that the accessions to the library during 1900 were the second largest on record.

The Junior Scientific Club held their 225th meeting on Friday, May 10. Prof. Odling read a paper upon the detection of arsenic.

Mr. E. L. Gill, of the Owens College, Manchester, has been appointed curator of the Hancock Museum by the committee of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne.

The late Mrs. Morton Sumner has by her will bequeathed to Bedford College for Women 4000*l.* and a large number of books specially relating to geology, general literature and art; also a valuable collection of mineralogical specimens.

A FACULTY OF COMMERCE is to be established in connection with the University of Birmingham, and the council of the University are prepared to appoint a professor, at a salary of 750*l.* a year, to organise a course appropriate for students preparing to take a lead in commercial pursuits or to become consular representatives or holders of administrative posts abroad or in the colonies. The aims and scope of the work of the new Faculty are outlined in a document drawn up by the principal, Dr. Oliver Lodge, and containing suggestions which should meet with general approval. There can be no reasonable doubt as to the need for the cultivation of scientific sympathies among men engaged in manufacture, commerce and public affairs. "If our country is to keep pace with others," remarks Dr. Lodge, "we have to provide in every post a highly-educated man, skilled in many business relations, as Consul, whose duty it shall be to understand the conditions of each trade, to realise how it may be improved or increased, and to make annual or more frequent reports, either to the Board of Trade or to local Chambers of Commerce, or both." The more administrators, officials and men of business we have capable of realising this ideal the better it will be for our national welfare; but the best way to provide the educational basis has yet to be decided. Dr. Lodge suggests that commercial education must centre round a school of Economics—understood in its widest sense—but this may be doubted, and we believe that it would be better to keep this school out of the early stages of the scheme. Too much importance seems to be attached to preliminary knowledge of "Arts" and other subjects required of students in the Commercial Faculty. It is suggested that "The preparatory training in fact should be a wide and comprehensive one including a little science as well as a good deal of Arts." To our thinking, however, a little science is not enough, and what is essential in the preliminary education is not the accumulation of information so much as the training of the mind to acquire and assimilate knowledge. Geography is not to be considered as a separate science in the new Faculty, and its various aspects will be surveyed by the professors of history, economics and geology. Dr. Lodge makes a number of other suggestions which, if adopted, will give the new Faculty a character worthy of the new University.

The paper on "School Work in Relation to Business" read before the Society of Arts on May 8, by Sir Joshua Fitch, and printed in the Society's *Journal* for May 10, contained an expression of views with which many people will find themselves in agreement. The fundamental idea, illustrated by reference to several subjects, seems to be that too much attention is given in schools to the application of rules and too little to the development of common sense. For instance, in arithmetic the pupils are given a number of empirical rules and are drilled in working questions based upon them, but they are taught next to nothing of the theory of number or of arithmetical operations. The average pupil is happy if the teacher will tell him whether he has to multiply or divide to work a simple question, and he asks helplessly what rule he should use when he is given a problem. But the pupil who has learned arithmetic as a science rather than as a collection of artifices for the working out of problems is in a condition in which he can find his own rules. Instead of regarding such processes as multiplication of fractions and extraction of square roots as a kind of numerical conjuring and legerdemain, he feels that his operations have a reasonable basis. The advantage of such knowledge is that it enables the pupil to invent his own method of dealing with problems and to adapt himself readily to any arithmetical work he may have to do later in a business house. Arithmetic as usually taught does nothing but develop mechanical facility in working sums, whereas it ought to be used to bring out thought and inventiveness.

Passing to measurements of length, volume and mass, Sir Joshua Fitch held with most of us that the metric system ought to take a more prominent place in the arithmetic course than is usually assigned to it, because of its increasing use both in science and manufactures. Then geography is a subject which is held in small favour in the public schools and in most secondary schools, yet when well taught it can be made, both from the educational and commercial point of view, one of the most fruitful of school exercises. Finally, no subject consciously designed to meet the needs of the shop or office should be taught in a primary school. The chief object should be education and the development of originality, rather than the acquisition of information and manipulation of rules. According to Sir Joshua Fitch the course of work in such a school should include "arithmetic in its principles, rapid calculation, the metric system, oral and written composition, industrial geography, and also some exercises in thinking about social economics and the way in which conduct and character tell upon the future honour and usefulness of the citizen." At the other end of the educational ladder are the universities, to which, it was held, we ought to look for more guidance than they have yet ever afforded in the solution of the great problem—the relation of scholastic culture to the duties of active life.

SCIENTIFIC SERIALS.

American Journal of Science, May.—Studies of Eocene mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman.—On the velocity of chemical reactions, by W. Duane. A description of two physical methods for following the velocity of a chemical change occurring in solution. In one of these the solution to be studied is placed in a wedge-shaped hollow prism and compensated with a similar wedge, the chemical change being followed photographically. A diagram is given showing the inversion of sugar as followed by this method. In the second method the change of volume of the solution is followed in a large thermometer.—The transmission of sound through porous materials, by F. L. Tufts.—On a yoke with intercepted magnetic circuit for measuring hysteresis, by Z. Crook. A description of a new form of yoke possessing certain advantages over the ordinary types. It gives practically a perfect hysteresis cycle, and can be used for studying the demagnetising action of electric currents without interrupting the magnetic circuit or varying it by means of a solenoid.—Mineralogical notes, by C. H. Warren. Crystallographic measurements and chemical analyses of anorthite crystals from Franklin Furnace, felspar crystals from Raven Hill, Colorado, iron wolframite from Dakota, and pseudomorphs of wolframite after scheelite from Trumbull, Conn.—On the expansion of certain metals at high temperatures, by L. Holborn and A. L. Day. Bars of metal 500 millimeters long were used, and enclosed in a porcelain tube heated electrically. The temperatures were measured with the thermocouple and ranged from 250° C. up to 1000° C. in the case of platinum, and in other cases to as high a temperature as the properties of the metal under examination would permit. Results are given for platinum, palladium, silver, nickel, constantan, wrought iron and steel.

American Journal of Mathematics, xxiii. 2, April.—The cross-ratio group of 120 quadratic cremona transformations of the plane. Part 2: Complete form-system of invariants, by H. E. Slaught, is the continuation of a memoir by the author which appeared in vol. xxii. (pp. 343–388). The text is accompanied by a large number of tables.—Memoir on the algebra of symbolic logic, by A. N. Whitehead, is a purely mathematical investigation, taking its rise in Boole's laws of thought. The credit of perfecting its laws of operation is assigned to C. S. Peirce and to Schröder. The keynote, according to the author, is the prominence given in his memoir to three ideas, viz. that of the "invariants" of a function of independent variables, that of "prime functions of independent variables," and that of the theory of "substitutions" of independent variables for independent variables. The last idea connects the algebra with the theory of groups and opens out a large field for investigation in that direction. The memoir, which occupies much space (27 pp.), is to be concluded in a subsequent number.—V. Snyder contributes a short note on a special form of annular surfaces. —On the transitive substitution groups whose order is a power of a prime number, by G. A. Miller, is a further contribution to a branch of mathematics for which the author has already done so much excellent work.—Geometry on the cubic scroll of the second kind, by F. C. Ferry, is a first instalment. Its object is to give a detailed treatment of several of the more interesting questions connected with the geometry of this scroll, and especially to consider the surfaces which can be passed through any curve on the scroll, so far as the order of those surfaces and the natures of the residual intersections are concerned. References are given to many memoirs bearing on the subject.

SOCIETIES AND ACADEMIES.

Royal Society, March 7.—"On the Heat dissipated by a Platinum Surface at High Temperatures. Part iv.—High-pressure Gases. By J. E. Petavel, A.M.I.C.E., A.M.I.E.E., John Harling Fellow of Owens College, Manchester. Communicated by Prof. Schuster, F.R.S.

The rate of cooling of a hot body in gases at pressures up to one atmosphere has received considerable attention, but with regard to gases at high pressures practically no data were up to the present available.

The present experiments were carried out with a horizontal cylindrical radiator contained in a strong steel enclosure, the enclosure being maintained at about 18° C. by a water circulation.

It is shown that the rate at which heat is dissipated by the radiator may be expressed by the following formula—

$$E = ap^{\alpha} + bp^{\beta}\vartheta,$$

where E = emissivity in C.G.S. units = total amount of heat dissipated expressed in therms (water-gramme-degrees) per square centimetre of surface of radiator per second; p = pressure in atmospheres; ϑ = the temperature of the radiator minus the temperature of the enclosure, or in other words the temperature interval in degrees Centigrade.

The gases studied are oxygen, hydrogen, air, nitrous oxide and carbon dioxide. In the case of the first three the formula holds good between 7 and 120 atmospheres and between 100 and 1100° C.

All the gases studied showed a rapid increase of the effective conductivity with the pressure.

Physical Society, May 10.—Prof. S. P. Thompson, president, in the chair.—A paper on applications of elastic solids to metrology was read by Dr. Chree. The object of the present paper is to exemplify the bearing of elasticity on physical measurements. Many of the results depend ultimately on a previous paper by the author, in which expressions were obtained for the mean strains and for the change in total volume of any homogeneous elastic solid acted on by any given system of forces throughout its mass or over its surface. The effect of the pressure of a surrounding medium of constant density upon the shape and volume of an isotropic solid is considered, and the theory is extended to the case of an æolotropic solid in a medium of varying density. The change in volume of the material of the walls of a flask containing liquid is next investigated, and it is shown that the change is independent of the thickness of the walls, the mean expansion per unit of volume being inversely proportional to the whole volume. Whether the alteration consists of an increase or a decrease depends upon the dimensions of the vessel. We cannot, in general, determine the effect on the internal capacity of a vessel due to the pressure of contained liquid, but if the walls are coaxial right circular cylinders, the common axis being vertical, the solution is possible. As a numerical example a glass tube 12·7 cm. high, 10 cm. internal diameter and 1·5 mm. thick would hold 0·11 grammes more mercury than it would if inelastic. The solution is possible in the case of a spherical shell, and this problem is also investigated in the paper. The author next considers the application of the theory of elasticity to standards of length, and to give a more exact idea of the problems actually occurring in metrology he deals particularly with five forms—the standard yard, the international prototype metre of X section, a working standard belonging to the Bureau International, and two deflection bars used in magnetometers. Most modern standards are supported, not over the whole lower surface, but either on two symmetrical rollers or on three points. In using standards of length it is the horizontal projection of the graduated surface that usually concerns us, and it is proved that unless we deal with a very long bar the difference between the chord and the arc is very small. The curvatures and lengths of bars supported in various ways, both loaded and unloaded, are treated at length, and it is shown that by a proper arrangement of supports the alteration in length between two points due to bending can be rendered so small as to be of no practical importance. In the metre prototypes of X section the divisions occur on the neutral surface and their distance apart is unaffected by stretching of the material. In the case of magnetometer deflection bars it is advisable to have the magnet light and as near to the bar as possible. Mr. Watson said that it was usual in deducing the radius of a coil from the measurement of its circumference with a steel tape to diminish the result by half the thickness of the tape. He would like to know if this was the right correction to apply. In measuring the circumference of a cylinder it is necessary to wind the tape in a spiral so as to bring the divisions side by side. This gives a result which is too great, and not too small as might at first sight be imagined. Dr. Lehfeldt asked if the work of the author could be used to determine the pressure corrections of thermometers. He would like to ask why it was necessary to use supports instead of allowing a standard to rest on a flat surface. The chairman said that the paper was important because of its bearing on the question of the relation between the units of different nations. He drew attention to the alteration of the factor converting metres into inches, and asked if it was due to alterations in the properties of matter or to errors of observation. The two legal definitions of the gallon differ by an appreciable amount, and it would be interesting to know if this discrepancy could be due to changes in the volume of measures due to the liquids contained by them. Dr. Chree, in reply to Mr. Watson, said the correction would depend upon the diameter measured, because that determined the curvature of the tape and, therefore, the stretching produced. In reply to Mr. Campbell, the author stated that direct experiments had been made upon the bending of bars and they agreed well with theory. The correction formula obtained for a thermometer is similar to the ordinary one used. A bar is usually supported so as to remove the uncertainty of the distribution of surface pressure when it rests on a flat surface not a true plane. In reply to the president, Dr. Chree said that the alteration of the factor converting metres into inches was probably due to errors of observation on account of the width of the divisions of the standard yard, and on account of the difficulty of obtaining the bar at the standard temperature of 62° F.—A paper by J. Rose-Innes and Prof. S. Young, on the thermal properties of isopentane compared with those of normal pentane, was read by Mr. Rose-Innes. In previous papers the authors have investigated experimentally the thermal properties of isopentane and normal pentane and have stated certain conclusions from their observations. The present paper gives the conclusions reached after a more exhaustive examination of the experimental results of the former papers. The quantity $RT - pv$ at any volume and temperature is called the departure from Boyle's Law at that point, and it is found that there is a constant ratio between the departures from Boyle's Law of isopentane and normal pentane at the same volume and temperature. To test the law a probable value of the ratio was determined, and by means of it a large number of values of pv for isopentane were calculated from results for normal pentane. These calculated values fall upon the same curve as the observed values and agree with them to within about 1 per cent. The authors are confirmed in their previous conclusion that the difference of pressure between two isomeric substances at the same temperature and volume involves the same power of the density as the first deviation from Boyle's Law, *i.e.* the second power. Mr. J. M. Gray said the numbers obtained would be valuable to him and he would make use of them in his calculations. He was sorry, however, that the authors had dealt with empirical formulæ instead of rational formulæ deducible from the theory of gases. Dr. Chree asked how the temperatures were measured. Mr. Rose-Innes said that recourse had been had to empirical formulæ because they found theoretical formulæ useless. He gave examples of the failure of well-known equations to satisfy experimental results. The temperatures were measured with a constant volume air thermometer, a small correction less than the errors of experiment being employed to reduce the readings to the thermodynamic scale.—The Society then adjourned until May 31.

Chemical Society, May 2.—Prof. Emerson Reynolds, president, in the chair.—The following papers were read:—The synthetical formation of bridged-rings. Part I. Some derivatives of bicyclopentane, by W. H. Perkin, jun., and J. F. Thorpe. Trimethylketobicyclopentanedicarboxylic acid,

$$\mathrm{CMe_2}\left\langle\begin{array}{l}\mathrm{C(CO_2H).CMe.CO_2H} \\ \;\mid \qquad\qquad \mid \\ \mathrm{CH} \text{———} \mathrm{CO}\end{array}\right. ,$$

when digested with potash, yields the lactone of trimethylhydroxybutanetricarboxylic acid,

$$\mathrm{CO}\left\langle\begin{array}{l}\mathrm{O—C(CO_2H).CHMe.CO_2H} \\ \qquad \mid \\ \mathrm{CH_2.CMe_2}\end{array}\right. ,$$

the anhydride of which is converted into the anhydride of a stereoisomeric acid by distillation. Ethyl dimethyldicarboxytrimethylenemalonate, $\mathrm{CMe_2}\left\langle\begin{array}{l}\mathrm{C(CO_2Et).CH(CO_2Et)_2} \\ \mid \\ \mathrm{CH.CO_2Et}\end{array}\right.$, is similarly hydrolysed by potash giving the lactones of the two isomeric dimethylhydroxybutanetricarboxylic acids,

$$\mathrm{CO}\left\langle\begin{array}{l}\mathrm{O—C(CO_2H).CH_2.CO_2H} \\ \qquad \mid \\ \mathrm{CH_2.CMe_2}\end{array}\right.$$

and

$$\left.\begin{array}{l}\mathrm{CO_2H.CH.CMe_2} \\ \;\mid \\ \mathrm{O—CO—}\end{array}\right\rangle \mathrm{CH.CH_2.CO_2H}.$$

—Lead silicates in relation to pottery manufacture, by T. E. Thorpe and C. Simmonds. Lead silicates or borosilicates, or complex silicates of lead and other metals, can be used instead of the oxides or carbonates as a means of introducing lead into pottery glazes. It is generally recognised that the employment of lead silicates for this purpose on the Continent has greatly tended to minimise the risk of lead-poisoning; this is due to the fact that the lead silicates used in the continental factories are of a high degree of insolubility so far as the lead is concerned. On examining a number of lead silicates used or proposed for use in England, many were found to be as easily attacked by dilute acids as the oxides or carbonates. The condition on which the insolubility of the lead depends was found to be, primarily, the existence of a certain ratio between the whole of the base-oxides, on the one hand, and the whole of the acid-oxides on the other. Provided that this ratio,

$$\frac{\text{number of acid molecules}}{\text{number of base molecules}},$$

falls within certain definite limits, the amount of lead extracted by dilute acids, such as the hydrochloric acid in the gastric juice, is always small.—The preparation and properties of 2 : 6-dibromo-4-nitrosophenol, by M. O. Forster and W. Robertson. This substance is prepared by the action of potassium hypobromite on paranitrosophenol in potassium hydroxide solution; a number of its derivatives are described.—The chlorination of toluene, by W. P. Wynne.

Geological Society, April 24.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—Notes on two well-sections, by the Rev. R. Ashington Bullen. The well-section at Southwark passes through sand and gravel, &c., 34 feet, London clay 75 feet, Woolwich and Reading beds 56 feet 9 inches, and Thanet sand 36 feet 6 inches, into chalk which was bored to a depth of 148 feet. The well-section at Dallinghoo post-office, near Wickham Market (Suffolk), penetrated 53 feet of blue chalky boulder-clay, into 20 feet of sand and gravel, water being found at a depth of 79 feet.—On the geological and physical development of Antigua, by Prof. J. W. Spencer. Antigua and Barbuda rise from the bank which occupies the north-eastern portion of the chain of the Lesser Antilles. The part of the bank on which these two islands are founded is submerged to the very uniform depth of about 100 feet, but from other island-groups it is separated by depressions of 1800 to 2500 feet. It is concluded from the erosion-features of the region that the region was an extensive land-surface, probably at least 2000 feet higher than now, during the Mio-Pliocene period, and was reduced by denudation to a comparatively low elevation before the close of that time. This was followed by a submergence (the Friar's Hill) to a depth of 200 feet below the present altitude. At the close of the Pliocene period there was another elevation to an extent probably exceeding 3000 feet, as shown by the channels on the submarine plateau between Antigua and Guadeloupe. This did not continue sufficiently long to complete the dissection of the tablelands, and consequently the Antigua-Barbuda mass remains intact. Then followed a subsidence culminating in a 75-foot submergence, a re-elevation to 100 feet above the present level, when the shallow channels in the submarine bank were formed, and possibly one or two other small movements.—On the geological and physical development of Guadeloupe, by Prof. J. W. Spencer. The Guadeloupe group is separated from the Antigua and Dominica groups by depressions 2000 feet deep. Much of Guadeloupe itself consists of eruptive rocks, evidently as old as the igneous base of Antigua. The land-surface during the Mio-Pliocene period appears to have been 2000 feet above the present level, but it was submerged 200 feet at the close of the Pliocene period during the accumulation of the Lafonde and Lower Petit Bourg gravels and loams. There was a re-elevation of about 3000 feet in the early Pleistocene period, and during this epoch *Elephas* could have crossed from the continent. This was followed by a depression to 100 feet or more below the present level, a re-elevation to 150 feet, submergence below the present level with growth of corals, and the elevation of these to six or eight feet above the sea.—On the geological and physical development of Anguilla, St. Martin, St. Bartholomew and Sombrero, by Prof. J. W. Spencer. Deep channels, not less than 1800 feet deep, separate the bank on which this group is founded from the banks to the north and south. The St. Martin plateau was a land-surface throughout the Mio-Pliocene period, during the earlier part of which it appears to have stood 2500 feet above its present level, and was probably connected with the now neighbouring insular masses, from which it was disconnected by denudation during a very long period of atmospheric activity, followed by a subsidence, so as to bring the present surface of the submarine banks to a level so low that the undulating features of a base-level of erosion could be formed on them; for, during the period when the deep and broad depressions on the Antillean chain were being fashioned, the now isolated island-groups stood out as table-mountains, which were slowly being eaten away by atmospheric agents. There was next a subsidence to about 200 feet below the present level, about the close of the Pliocene period, followed by a re-elevation to 3000 feet, as shown within the area, but in reality much more. It was during this early epoch of the Pleistocene that the great rodents described by Prof. Cope reached here from South America, but the race continued to live here sufficiently long to give rise to distinct species.—On the geological and physical development of the St. Christopher Chain and Saba Banks, by Prof. J. W. Spencer. The St. Christopher (St. Kitts) ridge rises from 2000 to 2800 feet above the submarine Antillean plateau, and is for the most part covered with shallow water, except between St. Kitts and Montserrat, where a depression reaches 2592 feet, and between Statia (St. Eustacius) and Saba, where it reaches 1200 feet. Relics of old igneous formations are found on the islands, but in most places they are covered by more recent volcanic formations. The group appears to have had the same physical history as the neighbouring groups of islands.

May 8.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—The influence of the winds upon climate during the Pleistocene epoch; a palæo-meteorological explanation of some geological problems, by F. W. Harmer. The views taken in this paper afford a simpler explanation of geological facts than those usually adopted. Instead of supposing that the climatic changes of the Great Ice Age, several times recurrent at intervals of a few thousand years, were due to astronomical or physical causes, it is suggested that the climate of the northern hemisphere being, from some unexplained cause, colder than that of our era, conditions of comparative warmth or cold may have been more or less local, affecting the great continental areas at different periods.

Entomological Society, May 1.—The Rev. Canon W. W. Fowler, president, in the chair.—Mr. C. G. Barrett exhibited for Mr. H. W. Vivian a specimen of *Xylophasia lateritia*, Hufn., a species not hitherto recorded in the British Islands, taken in South Wales by Mr. W. E. R. Allen; also *Deiopeia pulchella*, from the same district; *Dianthecia luteago*, var. *barrettii*, from one of the islands off the Glamorganshire coast, and varieties of *Eupithecia virgaureata*, much blackened, *E. lariciata*, *E. satyrata* and *E. exiguata*, taken by Mr. Vivian.—Mr. M. Jacoby exhibited specimens of *Heliocopris gigas*, L., from Mashonaland, and *Silpha biguttata*, Fairm., from Patagonia.—Sir George Hampson exhibited two females of an apterous *Lasiocampid* from the Transvaal, with cocoon and ova bred by Colonel J. M. Fawcett, 5th Lancers. The larva is very much like that of the British *Lasiocampa rubi*. The female does not emerge from the cocoon, its antennæ being aborted and all the joints coalesced with a flabellate organ with slight striæ indicating the joints; the fore tibiæ short with traces of tibial claws. The male is unknown.—Mr. H. St. J. Donisthorpe exhibited specimens of *Ripersia tomlini*, Newst., a coccid new to Britain, taken among *Lasius niger* at Portland in April 1900.—Mr. C. P. Pickett exhibited aberrations and varieties of *Lycaena bellargus*, *L. corydon* and *L. astrarche*, taken by him in August 1900 at Folkestone and Dover.—Mr. H. Goss exhibited a gynandromorphous specimen of *Lycaena bellargus* which he had taken at Reigate in June 1900. It had the characters of a male in the right wings, and the characters of a female in the left wings, which were, however, not entirely free from the blue scales of the male.—Dr. Chapman exhibited a cocoon of *Antheraea mylitta* and a flint from Redhill—two objects with practically nothing in common. Whilst dissenting *in toto* from those who see nothing in many cases of mimicry but accidental resemblance, he presented them with this as a case undoubtedly in accordance with their views, the cocoon and the flint being remarkably alike.—Prof. Poulton exhibited an apparatus invented by him to determine the strength of the formic acid discharged by the ant in defence of its nest. A discussion followed, in which Prof. Hudson Beare said he had found his skin affected by *Formica rufa*, and Mr. Donisthorpe that the skin had been removed from his hand and his gloves burnt in patches after being placed in the nest of the same species.—Mr. F. Enock exhibited numerous specimens illustrative of the metamorphoses of dragon-flies.—Mr. Enock read a paper entitled "The Metamorphoses of *Æschna cyanea*, illustrated by the electric lantern with photographs taken from life."—Sir George Hampson, Bart., communicated a paper on the classification of a new family of the Lepidoptera; Mr. Martin Jacoby a paper entitled "A further contribution to the knowledge of African Phytophagous Coleoptera"; and Mr. Gilbert Arrow a paper entitled "The Carabid genus Pheropsophus; notes and descriptions of new species."

Mathematical Society, May 9.—Dr. Hobson, F.R.S., president, in the Chair.—Major MacMahon, R.A., F.R.S., communicated two notes, on the series whose terms are the cubes and higher powers of the binomial coefficients and a case of algebraic partitionment.—Mr. J. B. Dale read a paper on the product of two spherical surface harmonics and Mr. H. M. Macdonald communicated a note on the zeros of the spherical harmonic $P_n^{-m}(\mu)$.—A note on a property of recurring series by Mr. G. B. Mathews, F.R.S., was communicated from the chair.

Royal Meteorological Society, May 15.—Mr. W. H. Dines, president, in the chair.—Mr. Rupert T. Smith read a paper on the periodicity of cyclonic winds, which was the result of a discussion of his own observations made in the neighbourhood of Birmingham during the twenty-six years 1874-1899. The equinoxes do not appear to be very stormy periods, but from the author's tables it is shown that the greatest frequency and force of cyclonic wind occurs some two weeks before the spring equinox and some three weeks after the autumn equinox.—Mr. W. Marriott gave an account of the bequest by the late Mr. G. J. Symons, F.R.S., to the Royal Meteorological Society. By his will Mr. Symons bequeathed to the Society his Cross of the Legion of Honour, the gold Albert Medal awarded to him by the Society of Arts, the testimonial album presented to him in 1879 by the fellows of the Royal Meteorological Society, and the sum of 200*l.*, as well as such of his books, pamphlets, maps and photographs of which there were no copies in the Society's library. Mr. Marriott stated that from Mr. Symons's valuable collection he had selected for the Society over 5000 books and pamphlets and about 900 photographs. A large number of the books were old and rare works, 750 bearing dates previous to 1800, while 8 were as early as the fifteenth century. By this bequest the Royal Meteorological Society now possesses the most complete and extensive meteorological library in existence.

CAMBRIDGE.

Philosophical Society, May 6.—Prof. A. Macalister in the chair.—The oscillations of a fluid in an annular trough, by Mr. B. Cookson.—Some experiments upon beams under endlong compression, by Mr. H. E. Wimperis.—Liveingite, a new mineral from the binnenthal, by Messrs. R. H. Solly and H. Jackson. This new mineral, to which the name "Liveingite" has been given in honour of Prof. G. D. Liveing, F.R.S., is a new member of the group of sulpharsenites of lead which comprise Sartorite $PbS + As_2S_3$, Rathite $3PbS + 2As_2S_3$, Dufrenoysite $2PbS + AS_2S_3$ and Jordanite $4PbS + As_2S_3$.—Note on the magnetic deflection of kathode rays, by Mr. H. A. Wilson. In this note the results of measurements of the magnetic deflection of kathode rays proceeding from kathodes of different metals are recorded. The results show that e/m is independent of the nature of the metal forming the kathode.—On the diminution of the potential difference between the electrodes of a vacuum tube produced by a magnetic force at the kathode, by Mr. J. E. Almy.—An attempt to discover radiation from the surface of metals carrying alternating currents of high frequency, by Mr. O. W. Richardson. The experiments were suggested by the corpuscular theory of the conduction of electricity in metals. The radiation expected was of the nature of secondary Röntgen rays. It was sought to detect this by its photographic effect and by the conductivity it would produce in the surrounding air. The maximum current density at the surface of the wires used was 130,000 amperes per sq. cm. and was produced by the discharge of two Leyden jars connected to an induction coil. A sensitive method was used to detect the leak, which was shown to be not greater than that generally present in air.

DUBLIN.

Royal Dublin Society, February 20.—Mr. J. Holms Pollok in the chair.—In the absence of Prof. W. F. Barrett, F.R.S., Mr. R. J. Moss read a paper by the Rev. H. V. Gill, S.J., on the stratified discharge in Geissler tubes, which was communicated to the Society by Prof. Barrett.—Prof. J. Joly, F.R.S., read a note on the pseudo-opacity of anatase.

March 20.—Sir Howard Grubb, F.R.S., in the chair.—Sir Howard Grubb read a paper on a new collimating telescope sight for large and small ordnance.—A paper entitled "Variation—Germinal and Environmental," by Prof. J. C. Ewart, F.R.S., was communicated by Prof. D. J. Cunningham, F.R.S.—Mr. J. Holms Pollok read a paper on a new thermo-chemical notation.—Prof. W. N. Hartley, F.R.S., presented a paper on the conditions of equilibrium of hygroscopic and deliquescent salts of copper, cobalt and nickel.—Dr. W. E. Adeney read a paper on ultra-violet spark spectra from the Rowland's spectrometer in the Royal University of Ireland.—Prof. W. F. Barrett, F.R.S., exhibited a series of recent radiographs.

April 17.—The Earl of Rosse in the chair.—Prof. J. Joly, F.R.S., read a paper describing a new form of electric furnace. The furnace consists of a fire-clay crucible in the walls of which a platinum wire, wound in the form of a spiral, is imbedded and through which a current is passed. Very high temperatures, up to the softening of the clay, are obtainable. A pattern in which the charged crucible is placed within an outer fire-clay vessel or muffle, heated as described, is recommended. Here the crucible may be of platinum or any refractory material. A reflector surrounds the muffle. A minute pattern was also shown in operation designed to give an intense local temperature in certain experiments on the viscosity of silicates. These furnaces are sufficiently durable to be of value in many experiments where a prolonged high temperature is required, controlable with considerable accuracy and free from flame contamination.—Prof. Joly also read a paper on a new method of identifying minerals in rock-sections by their birefringence. The degree of thinness which it is necessary to confer upon rock-sections is attended with the evil that the value of birefringence as a means of diagnosis is largely restricted to substances of high birefringence, the polarisation colours of many of the most important rock-forming minerals thus being but little differentiated. To overcome this difficulty, while preserving to the section the desirable transparency, the author, by a simple addition to the petrological microscope, sends the polarised ray twice through the section. This is accomplished by means of an opaque illuminator, an arrangement furnished by many makers, consisting of an attachment above the objective, containing a totally reflecting prism illuminated by light received through a frontal aperture, and transmitting the ray downwards through the objective on the object being examined, from the surface of which it is reflected again into the microscope. In the present application of the illuminator to the petrological microscope a nicol is attached over the aperture, and the ray totally reflected and transmitted downwards within the objective is (sensibly) plane polarised. Beneath the rock-section a small mirror of speculum metal or silver is placed. The ray after its first passage through the crystal under examination is reflected by this mirror, and the incidence being nearly normal is again returned through the crystal, thus traversing it twice before reaching the eye. It can be demonstrated, with a double image prism and by colour observations on a plate of selenite overlapped upon itself, that the loss of phase does not interfere with the accuracy of the method. This mode of examination at once introduces discriminative differences into the tints of many important substances, as the monoclinic and triclinic felspars, quartz, &c., all former differences of retardation being, in fact, doubled in amount.—Prof. Hugh Ryan read a paper on the synthesis of glucosides, and, in conjunction with Mr. W. Sloan Mills, one on the synthesis of galactosides.—Mr. R. J. Moss made some interesting experiments with liquid air by means of the Hampson gas liquefying apparatus.

Paris.

Academy of Sciences, May 13.—M. Fouqué in the chair.—On a perfectly astatic galvanometer, by M. Lippmann. The needle of the galvanometer described is mounted in such a way that it can be placed in the plane of the magnetic meridian and under the action of the current tends to move parallel to itself. Under these conditions the earth's field exerts no opposing force to the action of the current, and the apparatus is perfectly astatic.—On the theorems of Hugoniot, the lemmas of M. Hadamard, and the propagation of waves in viscous fluids, by M. P. Duhem.—On the real integrals of differential equations of the first order in the neighbourhood of a singular point, by M. Henri Dulac.—On certain involutive relations, by M. Maurice Lelieuvre.—On a problem of d'Alembert, by M. F. Siacci.—On an experiment in electrical oscillations, by M. H. Pellat.—The permeability of nickel-steels in intense fields, by M. René Paillot. Three classes were examined—irreversible steels, reversible steels, and steels containing small quantities of chromium and manganese besides nickel. In the first of these the magnetic permeability sensibly increased in the intense fields; in the second case, the reversible steel, the permeability attained a value of 1·19 for a field of 4000 C.G.S. units, and remained practically constant up to 30,000 units.—On the laws of outflow of air in musical instruments, by M. Firmin Larroque.—On the aromatic organo-magnesium compounds, by MM. Tissier and Guignard. It is shown that the halogen benzene derivatives react with magnesium in a manner exactly analogous with the halogen compound of the fatty series. As examples of the generality of this method, the preparation of triphenyl-carbinol, dimethylphenyl-carbinol and diphenyl-ethylene are described. In all cases the yields are nearly theoretical.—The decomposition of albuminoids into protoplasmides, by M. A. Etard. Decalcified bone, submitted to a simple hydrolysis, gives three groups of substances: glycocoll, leucine and a little tyrosine; a syrupy material very soluble in methyl alcohol; and a substance quite insoluble in methyl alcohol. The last compound has been analysed and is named bos-osteoplasmide.—Differences in the constitution of the bile according to the age and fatty state of the animal, by M. R. L. Craciunu.—On the phosphoric acid of the soil, by M. Th. Schlœsing, jun. An examination of the amount of phosphates removable from certain soils by repeated extraction with water.—On the composition of amblygonite, by M. Henri Lasne.—Histological researches on the sporulation of yeasts, by M. A. Guilliermond. At the moment of sporulation there appears to be a sort of solution of the red grains contained in the vacuoles, these bodies appearing to behave in some respects as a reserve material.

DIARY OF SOCIETIES.

THURSDAY, May 23.

Royal Society, at 4.30.—On the Presence of a Glycolytic Enzyme in Muscle: Sir Lauder Brunton, F.R.S., and Herbert Rhodes.—On Negative After-Images and their Relation to certain other Visual Phenomena: S. Bidwell, F.R.S.—The Solar Activity, 1833–1900: Dr. W. J. S. Lockyer.—A Comparative Crystallographical Study of the Double Selenates of the Series $R_2M(SeO_4)_2, 6H_2O$.—Salts in which M is Magnesium: A. E. Tutton, F.R.S.—On the Intimate Structure of Crystals. Part V. Cubic Crystals with Octahedral Cleavage: Prof. W. J. Sollas, F.R.S.

Royal Institution, at 3.—The Chemistry of Carbon: Prof. J. Dewar, F.R.S.

FRIDAY, May 24.

Royal Institution, at 9.—The Aims of the National Physical Laboratory: Dr. R. T. Glazebrook, F.R.S.

SATURDAY, May 25.

Royal Institution, at 3.—The Rise of Civilisation in Egypt: Prof. W. M. Flinders Petrie.

TUESDAY, May 28.

Royal Photographic Society, at 8.—(1) Practical Tricolour Photography; (2) The Optics of Tricolour Photography: E. Howard Farmer.

Anthropological Institute, at 8.30.—Measurements of Crania from the Fly River: J. Gray.—Anthropometrical and Craniological Notes on the Eastern Papuans: C. G. Seligmann.—Remarks on the Present State of our Knowledge of the Ethnology of British New Guinea: Prof. A. C. Haddon.

THURSDAY, May 30.

Royal Institution, at 3.—The Chemistry of Carbon: Prof. J. Dewar, F.R.S.

Institution of Electrical Engineers (Society of Arts), at 8.—Annual General Meeting.

FRIDAY, May 31.

Royal Institution, at 9.—With the Allies in China: A. H. Savage Landor.

Physical Society, at 5.—On a Model which imitates the Behaviour of Dielectrics: Prof. Fleming, F.R.S., and A. W. Ashton.—(1) On the Resistance of Dielectrics and the Effect of an Alternating Electromotive Force on the Insulating Properties of India-rubber; (2) Note on the Electrification of Dielectrics by Mechanical Means: A. W. Ashton.

SATURDAY, June 1.

Royal Institution, at 3.—The Biological Characters of Epiphytic Plants: Prof. J. B. Farmer, F.R.S.

CONTENTS.

THURSDAY, MAY 30, 1901.

A NEW TREATISE ON PHYSICS.

A Treatise on Physics. By Prof. Andrew Gray, F.R.S. Vol. i. Pp. xxiii + 688. (London: J. and A. Churchill, 1901.) Price 15*s.*

A BRIEF abstract of the contents of this book will suffice to show at once the enormous amount of information it contains and the labour which has been expended on its production. Its aim is "to provide a treatise on physics which may serve for those who, beginning at the elements of the subject, wish to have in one book an account of theoretical and experimental physics which may be sufficient for most practical purposes of scientific and technical education." Accordingly, the first volume contains nearly 700 pages devoted to dynamics and the properties of matter.

The book commences with an account of the fundamental units of measurement. Then comes a long chapter of nearly 100 pages given to kinematics; this is followed by chapters on dynamics, work and energy; after this we have statics of solids and fluids, gravitational attraction, astronomical dynamics, and the tides. The theory of elasticity fills some 70 pages, to be followed by 30 pages on capillarity, while the book closes with a very short section on measurements and instruments. As a book of reference, a kind of encyclopædia of physics, the work will be most useful; whether a student who is really beginning the subject would profit by the attempt to peruse it is perhaps open to doubt. For such a student the whole is too condensed; the range of subjects enumerated above is ordinarily dealt with in some six or eight different books, and though there is much force in Prof. Gray's protest against "the division of a great subject like physics into isolated compartments," yet most beginners will find that the subjects dealt with need a fuller treatment than Prof. Gray can give them, at least so far as their elementary parts are concerned.

It should be noted that the book contains no examples for the student to work out. Now while at Cambridge the practice of setting problems may be carried too far, most teachers will agree that it is only by practice in working examples that the fundamental laws of a subject such as dynamics can be driven home to an ordinary student. An engineer has to apply his mathematics to the questions which are brought before him for solution in his practice. The problems of the examination room differ, no doubt, in a marked degree from those which occur in real life, but a man who has been trained to their solution has a better chance of success when he is faced by some practical difficulty to which he must apply his mathematics than one whose training has consisted solely in studying the book work of his subject. However considerations such as these deal with the general scheme of the work, they do not touch the question, how the scheme has been carried out.

In looking at a new book on dynamics the reader turns naturally to the sections dealing with the laws of motion, and here the treatment might, we think, be clearer.

The ideas of inertia, mass, momentum, force, are not easily grasped by a beginner. Prof. Gray commences by the consideration of stress, the mutual action between two bodies whose relative motions are undergoing change; he then goes on to Newton's first law, in which the word "force" is introduced; it would be well to explain that the "impressed forces" of the law constitute one aspect of the stress which has been discussed just previously, indeed it may perhaps be questioned whether it is desirable to introduce the term stress at all in this connection. Strictly, a stress is measured by the force applied per unit of area; it has the dimensions of force divided by the square of a length, and we might more strictly call the mutual action between a falling body and the earth a force rather than a stress.

We then have a section on inertia or mass, and here Prof. Gray does not seem quite happy in his treatment. We are told that we get the idea of inertia from the observation "that different bodies have, when placed in what we are justified by experience in regarding *as the same circumstances*, different accelerations." Then we are to take the inertia of a body "as a measure of the quantity of matter in the body or, as it is called, the body's mass, and we shall see (§ 144) that the comparison of masses thus obtained must agree with that carried out by weighing." Again, the inertias of two bodies are compared by comparing the accelerations produced by applying to each in turn for one second a spring with a given stretch; the inertias are said to be inversely as the accelerations. Thus inertia is used throughout as equivalent to mass or quantity of matter, and practically the second law of motion, which, however, is not introduced until a later stage, is assumed; the spring with a given stretch exerts a definite force, and this force is equal to the product of the inertia and acceleration.

Such a treatment is open to criticism; for one thing the experiment suggested is an almost impossible one to perform; it is better either to start from some such statement as that whenever two bodies are moving under conditions in which each is free from all action, except that which arises from the second body, all the circumstances of the motion are consistent with the supposition that the ratio of the two accelerations is a constant, and to define this constant as the reciprocal of the ratio of the masses.

If it be objected, as perhaps it fairly may be, that the conditions assumed are never realised, we may have recourse to experiments with an apparatus such as Prof. Hicks's ballistic balance, in which two bodies swinging as pendulums are allowed to impinge directly in such a way that they are both brought to rest; experiments with this show at once that the ratio of the two velocities with which the bodies are moving at the moment of impact is a constant so long as the bodies remain unchanged. We define the ratio of the masses of the bodies as the reciprocal of this constant, and thus we obtain a means of comparing masses without the introduction of the idea of force; moreover, it is easy to pass naturally from this to the idea of mass defined as measuring the quantity of matter in the body.

Thus, having obtained a knowledge of mass and velocity, we can introduce the idea of force as the time rate of change of momentum, using Newton's second law to define and measure force.

Prof. Gray is careful to explain that he does not look

F

upon force as a cause of motion. Thus, § 138, when dealing with a simple pendulum, he writes: "The idea that F, T" (certain quantities appearing in his equations) "on the left denote forces in the sense of causes of motion and that the expression on the right are effects is a fallacy." He does, however, permit himself to speak of stresses as causing motion; it would surely be better to avoid the idea of causation entirely; it is doubtful if anything is gained by the distinction between "stress," as used by Prof. Gray, and "force." The term stress does, it is true, call attention to the fact that the action it denotes is a mutual one between two or more bodies, and this is wanting in the term force. Still, is is difficult to be consistent in the matter; thus, § 146, in dealing with Atwood's machine, we read, "putting T for the mass-acceleration *due* to the force applied to either mass"—the italics are not in the original. When once it has been explained that forces are measured by mass-accelerations, might we not write more simply and with equal effect the words, putting T for the tension of the string?

Observation shows us that in many cases the mass-acceleration of a particle is a constant; if we know the value of this constant from the conditions of the problem we can, having given the initial conditions, determine the motion; we say, for brevity, that the particle is moving under a constant force. In other cases, it has been observed that the mass-acceleration is a known function of the position of the particle relative to other particles. This function can often be calculated without any knowlegde of the velocity or acceleration of the particle; thus, if there be a second particle at a distance r from the first, each will have a mass-acceleration towards the other equal to mm'/r^2 where m and m' are the masses of the two particles. This is the force under which either particle moves. Having given this force, by equating it to the mass-acceleration, and solving the equations we can determine the motion. Thus the resolution of any problem of motion of a particle falls into three parts: (1) We determine from the conditions the mass-acceleration in each of three rectangular directions; (2) We equate these to the analytical expression giving these mass-accelerations in terms of the coordinates of the particle and their differential coefficients with respect to the time; (3) We solve the resulting equations.

We may consistently employ the name force for the quantities determined under (1), and indeed may speak of them as the forces impressed on the particle without implying that they are the cause of the motion. This is done in the later sections of the chapter. One other criticism occurs in connection with the sections of the book immediately under review. Prof. Gray writes, § 134, "The word weight is used in two senses, in the sense of the quantity of matter in a body, and sometimes, though perhaps more rarely, in popular language as the downward force of gravity on a body in certain specified circumstances. It seems impossible to discard the former use of the term even in scientific speech, and therefore we shall use the word generally in this sense and in the latter sense speak of the gravity of a body."

Again, in the next section we find the sentence, "We may take the inertia of a body as the measure of the quantity of matter in the body or, as it is called, the body's mass."

Thus weight and mass are to be used as synonymous, contrary to the practice of writers on dynamics during many years past. Such a change, unless the grounds for it be very strong, must lead only to confusion, and the fact that weight is used ambiguously in daily life is hardly a satisfactory reason for the innovation which has been adopted.

We have referred at length to these few pages of the work because of the importance of the fundamental ideas and conceptions with which they deal. It is impossible to deal with the rest in the same manner, nor, indeed, is it necessary. The reader will find the book a storehouse of valuable information, which is generally put clearly and well; experience alone will show whether or no it is useful for students "beginning at the elements of the subject." However this may be, the book should be found in every physical library, and is sure to be frequently consulted.

TROPICAL CRUSTACEANS.

The Stalk-eyed Crustacea of British Guiana, West Indies, and Bermuda. By Charles G. Young, M.A., M.D., Dublin, Member of the Royal Irish Academy, lately of the British Guiana Medical Service. 8vo. Pp. xix+514; 7 plates, coloured, and numerous outlines. (London: Watkins, 1900.) Price 12*s.* 6*d.* net.

FROM the equator to thirty-five degrees north the western Atlantic, with its neighbouring shores and rivers, can supply a group of stalk-eyed Crustacea not easily surpassed in interest by such a fauna from any other region in the world. The descriptions relating to this group lie scattered over numerous treatises. Dr. C. G. Young has conceived the meritorious idea of bringing them together under one cover. He modestly speaks of his performance as a hand-list for the use of collectors. Handiness and usefulness should therefore be among its characteristic features. As it lays no claim to originality, the virtues of accuracy, completeness and condensation might have been expected. In place of these there is offered to the student a volume expansively and expensively printed; serious omissions are balanced by a parade of unneeded trivialities; whilst from one end to the other slovenliness prevails in the use of older authorities and neglect or ignorance of those that are more recent. Like the curate with a questionable egg at an episcopal breakfast table, one might say of this book that "parts of it are good, my lord," but no one can tell which parts without consulting the very authorities which its publication presumes to be out of reach.

The first page includes an old definition of the class Crustacea, informing us that in these animals the body is "composed of segments, in general very distinct, motile," and this is followed by hundreds of pages dealing with crabs, in which, as Dr. Young well knows, for many or most of the component segments the distinctness is almost null and the "motility" absolutely *nil.* The end of the story is on a par with its beginning. It treats of the Squillidæ, and describes four species, adopting the synopsis of the genera from the work of Brooks on the *Challenger* Stomatopoda, but calmly assigning to the genus Squilla two species which, according to that very synopsis, belong to Lysiosquilla. The discussion of a true Squilla from the coast of Yucatan by J. E. Ives in 1891, and the truly valuable report on the Stomatopoda of the *Albatross* by Dr. R. Payne Bigelow in 1894, were evidently unknown to Dr. Young. Naturally, therefore, he leaves unnoticed the species new or old in this or other orders recorded by those two writers. Perhaps his attention was too much concentrated on older essays, and, as these are often much less accessible than modern treatises, such a fault would deserve to be leniently regarded. It was, indeed, with some eagerness that the present reviewer, on first opening the book, turned to the excellent index for the name Glypturus. Of this genus Miss Mary J. Rathbun last year published a new species from Brazil. That is not in the region with which Dr. Young's work is concerned, but the genus was established long ago by Stimpson in the *Proceedings* of the Chicago Academy of Sciences, vol. i. p. 46, 1866, with repetition in the *Annals* of the Lyceum of Natural History of New York, vol. x. p. 120, 1874, for a species "not uncommon among the Florida Keys." Of this Dr. Young has nothing to tell us. He mentions, indeed, two species of the same family, *Callianassa occidentalis*, Bate, and *Callianassa major*, Say, but he was obviously not in a position to inform his readers that Stimpson instituted the genus Callichirus to receive Say's species, and he does not take the trouble to tell them that Bate's species was founded on a single leg, which left Bate himself doubtful as to its generic position.

On generic and specific names and lists of synonyms there are various opinions, but most naturalists agree that quoted names had better be quoted correctly, and that an author would do well not only to verify his references, but to give others a reasonable chance of verifying them after him. Dr. Young's adhesion to these views may be complete in principle, but is made very doubtful by his practice. The scope of his work scarcely required a "synonymy" for the term Brachyura, still he has been pleased to give one. It leads off with the information that the word was adopted by 'Leach, Latreille, Dana, Linné, Claus, Haswell, Miers,' Linné's name as a centrepiece reminding one of those Welsh genealogies which are reputed to have Adam halfway down the ancestral line. Where and when Linnæus changed his *Cancri Brachyuri* into Brachyura we are not told, and are never likely to be. The synonymy continues in separate lines with '*Brachyura*, H. Milne Edwards,' '*Cancri Brachyuri*, Lamarck,' '*Klistognatha*, Fabricius,' '*Tetrogonostoma*' bracketed with '*Trigonostoma*, Macleay.' Here again we are not told when it was that Fabricius changed the Kleistagnatha of his Supplementum into Klistognatha, and as for the implied but ungiven reference to Smith's "Illustrations of the Zoology of South Africa," there is confusion doubly confounded. In that work McLeay adopts and uses the term Brachyura in common, not only with half a dozen authors, but with half a hundred or an indefinite number. He divides the group into two tribes, and it is to these he assigns the names above quoted, with the difference that he spells the first of them correctly as Tetragonostoma. In dealing with genera and species Dr. Young shows no more ceremony than with the higher groups. He attributes *Podochela reisei* to Stimpson, A. Milne Edwards and Miers, though certainly the first and last write the specific name *riisei*, and Stimpson says that it 'was found at the Island of St. Thomas by Mr. A. H. Riise, after which indefatigable investigator of West Indian natural history we have named the species.' For the genus Ibacus, Leach, Spence Bate's spelling, Ibaccus, is adopted, and Leach is accused of having written Ibachus. *Cardiosoma carnifex* is attributed to Herbst, though he died long before the species intended was assigned by Latreille to Cardisoma. The young German naturalist, von Willemoes Suhm, who died on the *Challenger* expedition, is uniformly referred to as Suhn. The Pandalidæ are defined without any regard to the discovery published by Caullery and by Calman two years ago that the front feet in this family had been misdescribed. And, as if all this were not enough, the unhappy author re-introduces the name *Uca una*, Marcgravè de Liebstad, without mentioning the year 1648 as the date of it, and in defiance, or perhaps in ignorance, of all the trouble and accurate learning with which Miss M. J. Rathbun has shown that this typical West Indian species ought rightly to be called *Ucides cordatus* (Linn).

There are some interesting local names given. We are told, for example, that *Panulirus guttatus* is called in Barbados the "Guinea bird lobster." The pages have satisfactory margins. There is room, therefore, for a naturalist with leisure, by supplementary notes, corrections and verifications, to give the book a solid value.

T. R. R. S.

PRACTICAL INORGANIC CHEMISTRY.

Praktikum des anorganischen Chemikers. Von Dr. Emil Knoevenagel. Pp. viii + 332. (Leipzig: Veit and Co., 1901.) Mk. 7.80.

THE fact that this book emanates from the Heidelberg Laboratory and is dedicated to the memory of the great teacher who first gave that laboratory its fame is calculated to enlist the expectant attention of a critic. The book purports to be an introduction to inorganic chemistry on an experimental basis, and the object is to associate the directions for practical work with adequate theoretical explanations of the phenomena involved. It is, in fact, a blend of preparations, qualitative analyses, quantitative experiments and theoretical chemistry. The plan of the work as a whole is hardly describable, but some idea of its detail may be gathered from the beginning. The student is told to weigh out four grammes of caustic soda, dissolve it in water and make up to 50 c.c. Then, parenthetically, he is asked to calculate the content of caustic soda per litre, to express this in gramme molecules and to say what is the normality. The student is next told the solubility of caustic soda at 15° and 100°, and also informed that the density can be used to measure the concentration. The boiling points of solutions of various concentrations are given. The solution is now to be tested with litmus and turmeric and also to be tasted. Caustic soda is affirmed to be a strong base. A piece is to be left exposed to the air; it is said to deliquesce and also to absorb carbon dioxide, a property of all strong bases. A piece is to be heated in an ignition tube, when t may be seen to melt. We now pass to the heading "Sodium Chloride, NaCl." Some of the caustic soda solution is to be neutralised with hydrochloric acid. Sodium chloride is said to be formed and the student is to write the equation and to make calculations as to the concentration and normality of the HCl solution. The solution of sodium chloride is evaporated until it crystallises, and the process is also observed under the microscope. The salt is tasted, some put into the flame and some treated with sulphuric acid. The next preparation is that of hydrochloric acid in quantity. The solution of the gas in water is to be examined on the same lines as the caustic soda solution. Some dilute acid and then some strong acid are to be heated in a test-tube, and the student is informed what variations of concentration have occurred. Then follows a disquisition on acids, bases and salts.

Space will not permit of further description of the course in detail. After the discussion of acids, bases and salts, we have the tests for hydrochloric acid; sulphuric acid follows, with remarks on its constitutional formula, its action on metals, &c. Nitric acid, hydrogen sulphide, carbonic acid, phosphoric acid and boric acid bring us, for the time being, to the end of the acids. Then come potassium, sodium and ammonium, followed by a discussion of their analytical separation. The rest of the book is much on the same plan. It ends with a chapter on the modern theory of solution (which is not employed in the body of the work) and details of the ordinary analytical separation. Tables of reagents, some density tables and a map of spectra are added.

The impression gained on reading through the book is that we have to do with a genuine attempt to combine accurate practical work with accurate theoretical knowledge. There is a great deal of admirable matter that is not usually to be found in books on practical chemistry. On the other hand, the style of the book is haphazard in the extreme and affords an example of logical detail without logical plan. There is also a constant variation of level in the instruction. A student who calculates the normality of a caustic soda solution and is soon after to have his attention briefly drawn to the possible constitutional formulæ of sulphuric acid is subjected to the indignity of trying the effect of his soda solution on litmus and turmeric paper. Then again, the student is told a great many things that he might easily and profitably establish by experiment, such as the fact that caustic soda exposed to air actually has absorbed carbon dioxide. It is desirable, no doubt, that the student of practical chemistry should understand the behaviour of concentrated and dilute acids on boiling, but the mere statistics of the subject are no explanation, and practical work on the subject should be linked to the simple generalisations that illuminate it.

It would not be right to dwell further on the weaker features of a book which, on the whole, is much more rational and luminous than the great majority of works on practical chemistry. It must be admitted that the task of writing a combined theoretical and practical work on chemistry is very difficult, and that Dr. Knoevenagel has given us a book that well deserves the attention of teachers.

A. S.

OUR BOOK SHELF.

Central Electrical Stations: their Design, Organisation and Management. By C. H. Wordingham. Pp. xvi + 496. (London: C. Griffin and Co., Ltd., 1901.) Price 24*s*. net.

WE venture to think that few, if any, persons could be found better qualified than Mr. Wordingham to write a treatise on central electrical stations, and there can be no question but that he has carried out his task in a very thorough and competent manner in the book before us. Whilst endeavouring to deal with practically every subject which enters into the organisation or management of a central station, the author has wisely given prominence to those matters which are not to be found already in other books. The central station engineer, especially if he have charge of a large generating station such as are now becoming more and more numerous, must be a man of wide experience and attainments, and it would be impossible to compress into one volume all the knowledge that he requires in his profession, quite apart from the consideration that such knowledge cannot be obtained from books alone. But whereas there is plenty of literature already dealing with the separate branches, such as steam engineering, dynamos, &c., there was none, until now, dealing thoroughly with the subject as a whole. Those who have charge of central stations, or those who are ambitious of attaining this distinction, will find Mr. Wordingham's book a very valuable guide.

Central station work has for long attracted a large number of young engineers, the rapid growth due to the spread of electric lighting offering great chances of advancement. It is true, perhaps, that now, as Mr. Wordingham says, the practice is becoming more settled and stereotyped and that entry into this branch of the profession will require a somewhat longer apprenticeship than has been usual hitherto; but this is not likely to discourage many, for the prospects for the future are even brighter than they were in the past. Large electric power schemes and the certain adoption of electric traction for tramways and urban railways point to an expansion which is sure to be both large and rapid for a long time to come. Those who are anxious to take part in this development cannot do better than study the book before us with care and attention. There is a fair amount in the book that is controversial, but this renders it none the less valuable; if the student is not always inclined to agree with the author, he will at least be benefited by the careful consideration of opinions derived from so wide an experience. Some may think, perhaps, that the clerical side of the organisation is given an undue amount of space; this is, however, only in accordance with the scheme of the work, seeing that this is one of those subjects not to be found in other books. Moreover, the student is too prone to think that scientific knowledge alone is sufficient to make a successful engineer and to underrate the importance of a sound and systematic organisation.

Hints to Travellers. Edited by John Coles. 2 vols. Pp. x + 436 and viii + 266. (London: The Royal Geographical Society, 1901.)

THIS useful work, of which the present issue is the eighth edition, has now been divided into two volumes. The first is devoted to the various problems of surveying and practical astronomy, and important additions have been made to the matter brought over from the last edition. The new chapters include a considerable expansion of the article on surveying, ordinary and photographic, a graphic method of predicting the occultation of stars by the moon, and an entire set of tables by the aid of which, and the *Nautical Almanac*, the traveller will have all the materials for computing the results of his observations.

Vol. ii. contains the articles on meteorology, photography, geology, natural history, anthropology, medical hints, &c. Of these, the sections on meteorology and medical items have been entirely re-written and considerably enlarged; the others all revised and brought up to date.

This work has already gained its reputation as a most serviceable and complete guide for almost all classes of travellers, and in its present elaborated form cannot fail to give additional satisfaction.

L'Optique des Rayons de Röntgen et des Rayons secondaires que en dérivent. Par G. Sagnac. Pp. 166. (Paris: Gauthier-Villars, 1900.)

THIS book gives a useful account of some of the properties of the Röntgen rays. The earlier chapters deal with the properties of the primary rays as they issue from the vacuum tube. A valuable feature is the explanation given of the cause of certain spurious effects which have been put forward as proving diffraction of the rays.

The second and larger part of the book deals with the secondary rays which issue from heavy metals when the primary rays from the tube falls on them. M. Sagnac makes it clear that this phenomenon is not properly to be described as a "surface effect." He shows that an element of volume of a heavy metal traversed by the rays gives out secondary radiation equally in all directions. The sudden change of conditions at the surface of the metal is not what is primarily concerned. The heavy metals absorb the primary rays so powerfully, however, that they can only penetrate to a small depth, consequently the secondary radiation does, in fact, come principally from near the neighbourhood of the surface. Many other original observations are described, but though of considerable interest they seem to leave the question of what causes the secondary radiation, and why only heavy metals emit it, almost as far from solution as ever.

R. J. S.

Cerebral Science. Studies in Anatomical Psychology. By Wallace Wood, M.D., Professor of History of Art in the New York University. Pp. xii + 128. (London: Baillière, Tindall and Cox, 1901.)

THE subordinate title of this book alone renders it impossible for us to take it seriously, despite the fact of its being dedicated to the memory of Taine and Broca. The book abounds in platitudes, ejaculations and short dictatorial declarations, with here and there an allusion to the historic, poetic and classic; but all without plan or logical sequence of ideas. The "creation of the human head—the study of the human brain," is defined as "the new science for the opening century," and "characterology" is regarded as the great field through which, by the study of man and the lower animals, there is to be reached the classification of souls. Of these our author would distinguish five classes, and when it is seen that he would locate the "strong" soul in the "parietal regions," the "good" in the "metopic chambers" and the "beautiful" in those of the "summit," we deem further comment needless, except to remark that the author is indeed amusing.

The Humane Review. Vol. i. April, 1900, to January 1901. Pp. 384. (London: Ernest Bell, 1901.)

WITH a few of the contributions to this volume, men of science and other observers of nature will find themselves in sympathy. Mr. W. H. Hudson pleads for the preservation of the furze wren or Dartford warbler, and other rare birds, and criticises the feather fashion; Prof. J. Howard Moore writes on the psychical kinship of man and the other animals; Mr. H. R. Fox Bourne states the claims of uncivilised races; M. Elisée Reclus champions vegetarianism; and Mr. Bernard Shaw makes amusing and characteristic remarks upon the alleged conflict between science and common sense.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The National Anti-Vivisection Society and Lord Lister.

I HAVE read your attack upon me in your issue of May 16.

In your comments on the anti-vivisection meeting at St. James's Hall you say that I "discoursed inaccurately on Lord Lister's scientific work." I did nothing of the kind, I never made any allusions whatever to his scientific work. You next say with respect to the fifty-eight vivisectors for whom Lord Lister signed certificates exempting them from the use of anæsthetics that "the probability is that personally he was not acquainted with half-a-dozen of the licensees." This is to bring a graver charge against Lord Lister than anybody has yet formulated, for the signature of Lord Lister is the evidence offered the public in the parliamentary report that the vivisectors in question are individually known to Lord Lister to be persons who will not inflict needless cruelties upon animals. I preferred to assume that they were all his intimate friends than to suppose that he had signed such certificates merely because he was asked to do so.

You are quite right in saying that I did not tell the audience that the vast majority of experiments under these certificates are mere "pin pricks." If I had done so I should have been misleading it. Inoculations may begin with a pin prick, but they commonly involve much subsequent suffering.

You next complain of my statement that "the more hospitals connected themselves with vivisection the larger was the grant per bed they might expect to receive from the Prince of Wales's Fund." It is simply waste of time to abuse me for making that statement till you can disprove it. I have given the figures and you will find them in the audited accounts of the hospitals.

Your account of what passed between my Society and the Poplar Hospital is inaccurate, and "the reply of this institution" cited by you is not to be found in the correspondence which has been published and which you should have read before affecting to quote from it.

Lastly, what we have suggested to the heads of the religious bodies in the matter of Hospital Sunday is, that if the offertories are to be handed into the general funds of hospitals from which same general funds schools licensed for vivisection are subsidised, the congregations should be informed from the pulpits that their money is not exclusively intended for the tending of the sick, but will in part be diverted to the education of medical students and to the support of vivisectional laboratories.

May I ask what is your objection to such a course being pursued?

I do not mind your attacking me in your paper personally by name—I have entered this controversy intending to give and expecting to receive good blows—but I have myself been scrupulous to make no statement that is not supported by unimpeachable authority, and I have a right to expect that a responsible paper such as yours should exercise a similar exactitude if it joins in the controversy and takes upon itself to allude to any statement of mine as "scurrilous."

STEPHEN COLERIDGE.

The National Anti-Vivisection Society, London, S.W., May 21.

[(1) Mr. Coleridge is reported to have stated that Lord Lister's experiment consisted in passing a needle and thread through the eyeball of a rabbit and leaving the thread there. The needle and thread were passed through a special part of the skin of the eye only (cornea). The object of the experiment would have been entirely frustrated if the needle and thread had been passed through the eye. The question to be answered was whether inflammation could be caused by irritation of non-vascular tissues. Speaking of Lord Lister's experiment as he did, showed that Mr. Coleridge not only did not take the trouble to get accurate fact with regard to the experiment, but also was totally ignorant of its object.

(2) The inference to be drawn from Mr. Coleridge's remark that Lord Lister was the "intimate friend" of fifty-eight vivisectors is that the signing of the respective licensees, exempting from the use of anæsthetics, was of the nature of a "job." This remark was obviously "scurrilous." Lord Lister signed

these certificates as President of the Royal Society; he knew the licensees to be fit persons to have the respective licenses, but there was no question of individual intimate friendship.

(3) The occurrence of pain after inoculation experiments is relatively very rare, and to refer to these experiments to a popular audience as vivisections is certainly misleading it, and Mr. Coleridge must have known this. The statement that the majority of these so-called vivisections were mere pin-pricks is true.

(4) We do not complain of Mr. Coleridge's statement of what he terms the "diversion" of hospital funds to the corresponding medical schools, but we simply say that the allotment of the Prince of Wales's Hospital Fund was not influenced in any way by whether a hospital had laboratories or so-called vivisectors attached to it or not. We regard the statement that Lord Lister wilfully diverted public funds to endow vivisection as scurrilous. We entirely deny that hospital funds are, by being used for the support of medical schools, "diverted," in Mr. Coleridge's sense, from the patients. Medical schools are essential to large hospitals, and any grant made to them out of hospital funds is only in return for services rendered, although it indirectly helps the progress of medical science.

(5) The statement that Mr. Coleridge tried to make a bargain with a London hospital concerning the appointment of its staff and that the hospital declined is true; the mere wording of the reply is a matter of no importance. If Mr. Coleridge will publish the correspondence to which he refers we shall be prepared to consider it exhaustively.

(6) We entirely object to the relation between hospitals and medical schools being put before the public subscribers to the Hospital Sunday Fund in the way Mr. Coleridge suggests. If Mr. Coleridge has any scheme by which the large hospitals can receive the services of the medical profession more cheaply than they do at present he is quite justified in putting this before the public. He is, however, not justified in stigmatising grants made to medical schools as being "diverted" from the use of the sick.—EDITOR.]

Vitrified Quartz.

A STUDY of the viscous properties of vitrified quartz in which I was engaged last year, and which I communicated to the Geological Congress of 1900, revealed a degree of plasticity and molecular instability which I think justify Mr. Shenstone's reserve in pronouncing on the applicability of this substance to thermometry at high temperatures (NATURE, May 16). A few of the measurements I obtained may be of interest. I may observe that the method of observation was to stretch a quartz fibre (as supplied by the Cambridge Instrument Co.) in a horizontal platinum tube, which is heated by a current and clamped in the meldometer, its temperature being determined in terms of its thermal expansion. The fibre, which passes axially through the tube, is fixed at one extremity, and at the other is attached to a light pendulum, the mass of which can be increased, and which it deflects from the vertical. It is observed by two micrometers placed at some few centimetres to either extremity of the tube, so that any slip in its fixed attachment will be detected. The tube is 10 cm. in length and ·2 cm. in diameter. Tensions are calculated in kilos. per square centimetre, and rate of elongation in centimetres per minute per unit of tension per centimetre of fibre. The different fibres used are designated *a*, *b*, *c*, &c.

Fibre	Temperature	Duration of observation in minutes	Tension	Rate of stretch per unit of tension
a	715°	270	638	$0·23 + 10^{-8}$
b	735°	95	1350	0·16 ,,
b	785°	165	,,	0·66 ,,
c	870°	150	82·2	1·3 ,,
c	915°	60	27·4	5·3 ,,
c	,,	50	54·8	4·4 ,,
c	920°	60	82·2	6·2 ,,
d	915°	10	422	6·6 ,,
e	940°	10	320	8·5 ,,
f	1040°	10	,,	35·9 ,,

This table is abridged from one giving fuller details. The fibres varied greatly in diameter and possibly somewhat in their viscous properties, but the results are all one way—an increasing yield with increasing temperature and a rate of stretch approximately proportional to the applied force. But this last assertion cannot go without some reservation. At the higher temperatures, the rate of elongation was observed to diminish steadily when the observations were much prolonged. Ultimately the fibre generally breaks. When observed now between crossed nicols the fibre is found to be partially crystallised, the crystallisation extending inwards from the surface. This crystallised layer is sometimes cracked and peeled from the core beneath, the result, probably, of the very great volume-change attendant on crystallisation. The gradual diminution in rate of stretch, and a certain degree of irregularity in the results at higher temperatures, may well be due to this molecular alteration.

So far as can be inferred from the observations, the results are due to plasticity, complicated at higher temperatures by gradual crystallisation. Nor is there anything, so far as I can gather, in the least opposed to this view contained in Prof. Callendar's interesting experiments on the thermal expansion of vitreous quartz.

It will be seen from the experiments I have quoted that the viscous stretch at the lower temperatures is small in amount. With prolonged use, however, and if any considerable difference between internal and external pressure existed, thermometers would be affected by it sufficiently to necessitate frequent re-adjustment of fixed points. I find, for example, as the result of a rough estimation, that with an excess of pressure of one atmosphere within, a spherical bulb 1 cm. in diameter and ¼ mm. thick in the walls would, at 785° C., increase in volume by 0·1 per cent. in about 83 hours. At 870° C. this increase will occur in about 40 hours. At 920° C. the same increase in volume would occur in about 8 hours if the contraction due to crystallisation, which the experiments lead us to expect, did not act the other way. The final result, after 8 hours' heating at 920° C., would be impossible to predict.

I have more recently found that vitrified quartz, reduced to powder and exposed over a Bunsen for 35 days in a closed unglazed porcelain crucible at a temperature just under the melting-point of gold (1066°) loses its sharp edges, rounding every point and angle, and simultaneously develops incipient crystallisation, which appears in the form of radial spherulitic structures, often with anisotropic centres. J. JOLY.

Geological laboratory, Trinity College, Dublin.

Statistical Investigations on Variability and Heredity.

EARLIER appeals in your columns have met with such friendly response from scattered workers that I venture again to trouble you with an appeal for aid. I have three investigations in progress wherein help would be very welcome:—

(1) The measurement of physical and intellectual characters in pairs of brothers or sisters. Upwards of 1400 have now been observed and measured, but I have still not sufficient data. Village schools usually present a great deal of measurable material, but it is difficult to reach their teachers except through individual approach. Any of your readers who can interest their local teachers in observing and measuring pairs of children will do me a great service, and I shall be glad to send papers of instruction and a head-spanner for their use.

In examining carefully the data from nearly thirty primary schools recently returned to me, I only found two cases in which the teacher had not been fully able to use the spanner to advantage. Of course I shall be equally pleased to send papers and head-spanners to masters or mistresses in secondary schools.

(2) I shall be glad of any number of orange-tip male butterflies. They must have been caught wild and not bred, and I should like contributions from as many districts as possible. The specimens need not be very carefully set, and if the upper wings are not badly damaged they will be sure to be of use.

(3) Clutches of blackbirds' or thrushes' eggs. Each clutch must be kept perfectly separate, and certainly be from one bird. They are better unblown. If blown the hole or holes must not be at the ends. As some of your readers may have clutches they wish to preserve, but would not mind the risk of lending, I will return those so desired.

Contributions desired under (2) and (3) are for determining the intensity of homotyposis, a factor, I believe, to be at the basis of all hereditary resemblance. KARL PEARSON.

University College, London, W.C., May 25.

Prehistoric Implements in the Transvaal and Orange River Colony.

THE reason for writing these short notes is the desire to point out to those with the requisite knowledge the places where what are probably palæolithic remains can be found in South Africa. I am not able to dilate on the technical side of the question, having only a smattering of the subject.

Being a volunteer in the British Army, the immense distances covered by us gave one an opportunity of seeing a larger tract of country than would be possible as a civilian. Unfortunately, in South Africa the amount of systematic research into the subject of prehistoric weapons has been but small, and I think the Orange River Colony and the Transvaal would be found very rich in all such remains. The heavy rains and nature of the country allow many glimpses of the geological formations, and the dongas and dry river banks will nearly always reveal some old "drift." The nature of our marching did not allow us to go far from the beaten road, but a few worked stones could be picked up in every day's march.

Starting at Sterkstroom, with the 3rd Division, such specimens can be found all round the town of about 2 inches in length in a fair state of preservation, some few showing the effect of being water-worn. At a coal mine named Wallsend, the hill where we camped is simply covered with scrapers and chips; in fact I collected quite a dozen in the small circle covered by our bell tent. Further north, at Bethulie Bridge, they are lying in the subsoil of the river bank, as well as in the stony reaches of the river. Springfontein, Smithfield, Dewetsdorp, in fact right up to Bloemfontein, the country is covered with stones all about the same size, roughly chipped and, in all probability, of palæolithic origin. They are of the leaf form and vary from 1 to 2½ inches in length.

At the Vaal River they were more water-worn and larger, about 5 by 2 inches. Better specimens could probably be obtained by examining the drift, which I myself had no opportunity of doing. I found only two or three specimens round about Pretoria. Middleburg and Belfast were the last two places I was in, and in the former an immense quantity of implements can be picked up in the river bed and in the subsoil adjoining. They are of the large size, as those in the Vaal River, some which I found being about 5 by 5 inches and quite 1 inch thick.

Unfortunately, Army regulations as to the weight of kit had to be carried out, and I had three separate times to throw my collection away. I had kept the best specimens and ticketed them, but in the end I found myself discharged from the Army as a time-expired volunteer in Cape Town, with only three or four dilapidated specimens from Belfast.

If regulars and volunteers would write about their observations of other parts of the country covered by them it would indicate at a glance the richest places where a systematic research could be undertaken with the best possible results.

Sunderland. STANLEY B. HUTT.

The Age of the Woburn Abbey Musk-Ox.

IN the notice of the young musk-ox at Woburn Abbey which appeared in NATURE of May 16 it was stated that the animal was considerably more than two years of age when the photograph was taken. This age was assigned on account of a statement made by Dr. Allen in his recent memoir on the Greenland and American musk-oxen that the Woburn specimens must have been yearlings when they were first photographed in 1899. His reason for making that statement were that a young calf captured at Fort Conder in May, 1899, had a black face, instead of the white-spotted faces of the Woburn animals; and that the latter had consequently changed their coats. Now the Woburn specimens were captured on Clavering Island on August 16 of that year, and from information that has recently been supplied to me it seems almost certain that they were calves of that year, probably born the preceding April or May. If this be so, and if calves have black faces when first born, it would seem that the Woburn specimens had already changed their first coats when shipped for England during the late summer, a photograph of them having been taken on board ship showing the white faces. It thus appears that when the photograph reproduced in NATURE was taken, the animal was not more than two years old, and possibly rather less. R. LYDEKKER.

The Subjective Lowering of Pitch.

As a general rule, the pitch of a musical note does not in any way depend upon its intensity, but solely upon the wave-length. It appears probable, however, that any wave motion of very great intensity produces distorted effects. Thus we find that a very loud sound may so affect the ear of the observer as to appear flatter than it really is. This is a purely subjective effect.

Dr. Burton was, I believe, the first to investigate the phenomenon, and some of his results (together with his explanation of them) will be found in vol. xiii. of the *Proceedings* of the Physical Society. My own attention was first drawn to the matter by observing what appeared to be the false intonation of certain singers upon loud notes, either when I was conducting near those singers or when I was rehearsing in a small room. Reading then of Dr. Burton's researches, I was led to investigate them for myself.

The subjective lowering of pitch is an undoubted fact, *i.e.* a very loud note does appear flatter than it really is.

If a C tuning-fork (middle C, 256 vibrations per second) be *strongly* bowed, and then be quickly brought near the ear, before its loud note has had time to die away, the sound will appear flattened to about $B\flat_1$, or even A_1, the amount of the effect being different to different ears.

It is more difficult to obtain the effect with higher forks; indeed, a C^1 fork (512) must be bowed very strongly indeed to give the effect at all. An E fork (320) appears to give a flat $D\sharp$, and a G fork (384) gives $F\sharp$.

The effect is a subjective one, caused by great intensity, for it vanishes as the sound gets softer, and can then be restored by bringing the fork nearer the ear, thus again increasing the intensity. In this last case the restoration of effect is sudden, and is not due to any gradual movement of the fork (Doppler's principle).

If the position of the source of sound be fixed, the subjective note gets sharper as the intensity of the vibrations gets less; for instance, an E fork (320), when very strongly bowed, gave $C\sharp$ as its subjective note; but, as the vibrations died down, this $C\sharp$ varied to D, then became $E\flat$, and finally and suddenly stopped altogether.

The amount of the subjective effect differs with different individuals, both in pitch and in intensity. What to one person appears a flattening of a minor 3rd, to another auditor appears a flattening of only a major 2nd, but in every case it appears to be a flattening and not a sharpening. Also the loudness of the subjective note appears different, even to the different ears of the same person.

In the case of some organ-pipes tested, the following results were obtained:—

C pipe (open, 256) gave A_1 as subjective.
E pipe (open, 320) gave D as subjective.
G pipe (open, 384) gave $F\sharp$ as subjective.
C^1 pipe (open, 512) gave B as subjective.

If an ear-trumpet be used, a very loud source of sound is not necessary in order to obtain subjective effects. If the source of sound be placed at a distance just great enough to prevent subjective flattening, and then an ear-trumpet be used, the subjective note at once appears.

Much of my own musical work has been done amongst male voices, and I have frequently noticed that a singer of good concert-room power may, if practising in a small room, seemingly sing with flat intonation. I should be glad to have further experience concerning this from your contributors, who will also, I hope, have noticed the effect in the case of brass instruments.

E. HURREN HARDING.

Normal College, Bangor, May 15.

RECENT STUDIES OF OLD ITALIAN VOLCANOES.

THE abundant and well-preserved extinct volcanoes of Italy have long had a great fascination for students of geology. So many allusions to them are scattered through the literature of the science, and so many accounts of them, more or less brief, have been furnished by those who have visited them, that their general characters and the more important varieties of their rocks are now tolerably familiar. But until lately hardly any of them have been subjected to that minute dissection which modern vulcanology and petrography now demand. The Italian geologists, however, have at last taken up the investigation in considerable detail, and are issuing excellent maps and monographs of different volcanic districts, which well deserve the careful attention of all who take an interest in the progress of volcanic geology. To some of the latest of these publications a brief reference may here be made.

The Italian Geological Survey has entered upon the study of the volcanoes of Central Italy and their products, and as a commencement has issued a detailed account of that remarkable volcanic centre which forms the group of the Alban Hills to the east of Rome. This work has been accomplished by one of the staff, Mr. V. Sabatini, who has long been known for his geological enthusiasm.[1] It forms a volume of nearly 400 pages, with an excellent map of the region, ten plates of views and petrographical sections and 79 figures inserted in the text. After a brief introduction devoted to a discussion of some of the theoretical principles involved in the interpretation of volcanic phenomena, the author proceeds to give a sketch of the topography of the region and of the position of its several eruptive vents. He recognises, as at Vesuvius, the records of two great periods in the volcanic history. The first, one of conspicuous vigour, which built up a large cone that was finally demolished by a stupendous explosion; the second, one of minor force, whereby a cone was formed within the original circuit. Each of these phases has been attended with the production of secondary or adventitious cones, and the author endeavours to trace a series of lines of fissure along which, in his opinion, these cones have been produced. It is to be noted that some of his lines appear to rest merely on the evidence of carbonated or sulphurous springs, and even where they run from cone to cone some effort of imagination is needed to picture the lines of fissure as he gives them. In Southern Italy the geologists are less fanciful in dealing with the unseen substructure of their volcanoes.

The second chapter treats of the various hypotheses which have been proposed in explanation of the origin of the Roman Campagna and the Alban Hills, and especially of the tuffs so widely developed in that region. A detailed description of these tuffs is given; they are classified as lithoid, homogeneous, granular, pumiceous and earthy, and reference is made to the terrestrial flora and fauna enclosed in them. Their plants include many familiar living species. On Monte Celio, land-shells were found; on Monte Verde, the molluscs were of fresh-water species; in the tuffs between Nettuno and Astura, Meli has collected a considerable number of marine and estuarine forms, while a large assemblage of bryozoans has been gathered from the volcanic tuffs of Anzio and Nettuno. The succession of the different varieties of tuff is next given as displayed in many sections in and around Rome, and an attempt is made to estimate the cubic contents of the vast sheet of tuff which has been discharged from the Vulcano Laziale.

The third chapter deals with the nature and classification of the Latian lavas. These are grouped into normal leucitites and leucotephrites. The alterations which they have suffered are described, such as the transformation of leucite into felspar. Detailed descriptions are then given, in chapters iv. and v., of the rocks of each important part of the outer and inner cones of the volcano, and the author, following a practice for which he no doubt can cite high authority, adopts a somewhat complicated and cumbrous system of symbols to express the petrographical characters of each rock. Such a system may be convenient, especially where rapid comparisons of different species and varieties of rocks are desired by a student who has taken the time and labour necessary to understand it and commit it to memory. But life is too short and geological literature is too long for such a task on the part of ordinary readers. It would not have cost much more type to have accompanied the symbols with a brief statement of the composition of the rocks in plain language. The origin and constitution of the craters of Nemi, Castel Gandolfo and Ariccia take up the next three chapters. The author here, as in the rest of the volume, deals less fully with the tectonic than with the petrographical part of his subject. He would have added much to the geological interest of his memoir had he given more ample details of the structure of the great volcano and presented a clear and vivid outline of the whole succession of volcanic phenomena of which it preserves the record. Perhaps he may intend to deal with these parts of his subject in a subsequent treatise. A useful bibliography is appended to the volume. It is much to be desired, however, that precise references had always been given to the passages in the works of the authors whose names are cited in the text. The continuation of the important research of which Mr. Sabatini gives here the first instalment will be awaited with much interest.

In Southern Italy the investigation of volcanic phenomena is naturally incited by the irresistible attractions of the active volcanoes of that region. The study of the extinct cones and craters, however, has perhaps rather been retarded by the abundant opportunities offered there of witnessing the actual progress of eruptions. Within the last few years the subject of the older volcanoes has been taken up by several observers, who, without the resources of the National Survey to assist them, have nevertheless been successful in bringing much fresh information to light. Two of these geologists—Prof. G. de Lorenzo, of the University of Naples, and Prof. C. Riva, of the University of Pavia—deserve especial commendation for the enthusiasm of their researches. The volume just issued of the *Transactions* of the Royal Academy of Naples contains two detailed memoirs, one by Prof. G. de Lorenzo on the well-known Monte Vulture between Naples and the Adriatic, the other by the two authors conjointly on the seldom-visited crater-island of Vivàra between the islands of Ischia and Procida in the Bay of Naples.[1]

The memoir on Monte Vulture extends to 207 closely printed quarto pages, and is illustrated by numerous figures in the text as well as a map and a number of excellent plates in photogravure, of which one is here reproduced. In an introduction, the history of observation regarding this ancient volcano is briefly sketched. The author then proceeds to describe the various sedimentary series through which the volcanic explosions took place. These consist of Trias, Cretaceous, Eocene and Miocene formations, together with Pliocene and Pleistocene deposits both marine and terrestrial. The stratigraphical relations of these various groups of strata had already been discussed by M. de Lorenzo in a paper on the geology of the Southern Apennines, published in 1896, and they are well displayed in a plate of sections accompanying the present monograph. The incomplete series of Mesozoic formations is shown to have been considerably disturbed before Tertiary time, while the Eocene and Miocene deposits had likewise been plicated and denuded before the Pliocene strata were laid down upon them. In the southern outskirts of the mountain the volcanic pile rests on the younger Tertiary groups, while towards the north it spreads over the area of the Eocene and Miocene "Flysch." The faulted nature of the

[1] I vulcani dell' Italia Centrale e i loro Prodotti. Parte Prima—Vulcano Laziale, di V. Sabatini. Roma, 1900. (R. Ufficio Geologico. Memorie Descrittive della Carta Geologica d' Italia, vol. x.). This volume, the author informs us, is based on the work of 112 days in the field and the examination of 400 microscopic slides of rocks. The volcanic centre here referred to under the name of "Vulcano Laziale" comprises the Monti Laziali and the Monti Albani and their surroundings.

[1] "Atti della Reale Accademia delle Scienze Fisische e Matematiche di Napoli," second series, vol. x. 1901.

ground is well shown in some of the illustrations, but the author does not believe that Monte Vulture has had its site determined by the stupendous linear fracture which some theorists have imagined to extend eastwards from Vesuvius. He has satisfied himself, by a study of the geological structure of the surrounding country, that no trace of any such dominant dislocation exists.

The various rocks of the volcanic pile are then described in some detail. They are shown to form a numerous and continuous series of varieties between the two extreme limits of trachytoid phonolites, on the one hand, and basalts on the other. The principal types of lava are thus arranged: Hauyne-phonolite, anorthoclase-phonolite, hauyne-tephrite, leuco-hauyne-tephrite, leuco-hauyne-basanite, leucitic basalt, leucitite, nephelinite, hauynophyre. Each of these types is fully described and is illustrated by excellent plates of its microscopic structure. A section is devoted to the characters of the agglomerates by which the lavas are accompanied, and another to the inclusions contained both in the lavas and the fragmental materials, some of which were doubtless derived from the underlying sedimentary platform, others probably represent portions of the subterranean magma which have acquired a granitoid structure at a great depth, while in some cases their origin is doubtful.

Having described the materials of the volcanic pile the author next furnishes an account of the way in which they have been built up into the huge mass of Monte Vulture. In a long and interesting section of the paper the structure and probable history of the mountain are discussed, and the position of its various rocks and some of the successive phases in the evolution of the topography are explained in diagrams inserted in the text. The next division treats of the lakes which, partly in consequence of the volcanic disturbances, were formed in some number and of considerable size during Pleistocene time. This subject had already been treated by M. de Lorenzo in a separate memoir (*Atti Accad. Scien. Napoli*, 1898) in which he had shown that Southern Italy in Quaternary time was dotted over with large and small basins of fresh water. Whether formed in consequence of changes in the topography produced by the volcanic eruptions or existing before these eruptions began, the lakes around Monte Vulture were more or less filled up with limno-volcanic tuffs containing fresh-water shells and likewise remains of *Elephas antiquus*, *Hippopotamus major*, *Ursus spelaeus*, *Felis spelaea*, *Hyena spelaea* and *Cervus elephas*.

In a final section the author states what he believes to be the bearing of the history of Monte Vulture on theoretical questions of volcanism. He insists on the total independence of the eruptions of this centre, which he thinks had no direct communication with those of any other. He can find no trace of the great connecting fissures which have been supposed to link together all the old and modern volcanoes of Southern Italy. He regards the eruptions of this centre as having begun long after the great orogenic movements that gave rise to the Apennine chain, and at a time when perennial snows and glaciers still lingered on the surrounding heights. Phonolitic lavas first made their appearance, followed by tephrites, basanites and basalts, which form the great mass of the mountain. Two peripheral vents can be distinguished, one anterior, the other posterior to the formation of the great central cone. The last stupendous manifestation of volcanic energy seems to have been the explosion which blew out the great crater in which the two crater-lakes of Monticchio now lie (Fig. 1).

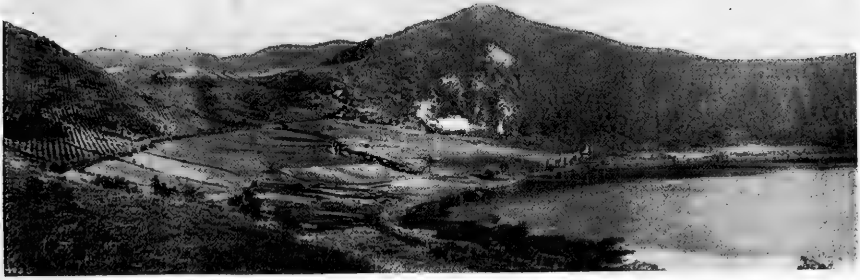


FIG. 1.—View of the interior of Monte Vulture, showing the great exterior rampart and the crater lakes of Monticchio.

M. de Lorenzo acknowledges the important services rendered to him by his friend Prof. Riva—the young and accomplished mineralogist of Pavia whose petrographical assistance and photographic skill were freely given in the preparation of this important monograph. The other memoir above cited is a joint production of the two observers. It is entitled "Il Cratere di Vivàra nelle Isole Flegree," and forms No. 8 in the same volume of the *Transactions* of the Naples Academy. It begins with an interesting historical introduction and then at once enters on a discussion of the rocks of which the remarkable island is composed. These consist entirely of fragmentary materials which have been heaped up around a crater, as in the other volcanic cones of the Campi Phlegræi. A careful account is first given of the coarse breccias or agglomerates, which include blocks of trachytic obsidian, sanidinites with quartz and catoforite, anorthoclase-trachytes with ægirine, augitic trachytes, mica-trachytes, andesitic trachytes, basalts, trachydolerites, rocks of dioritic type (monzonites) and other varieties. Full petrographical descriptions of these rocks, together with micro-photographs of their internal structure, are given. The varieties of pumice, lapilli and tuff are likewise detailed. It is shown that the eruptions of Vivàra, unlike those of the neighbouring region, did not consist solely of trachytic material, but discharged an admixture of a trachytic and a basaltic magma, so as to have heaped up a rich assortment of the most remarkable rocks, beginning with a quartziferous sanidinite and passing through various trachytic types to normal olivine-basalt. The relations of these rocks to the other similar materials in the Phlegræan region are next discussed, and the authors then pass to the structure of the island, which they show to consist of successive sheets or banks of ejected fragmentary volcanic material without any accompanying lavas, and disposed in the usual divergent arrangement, the portions on the outer surface of the cone dipping steeply outwards into the sea, while those on the inside are inclined towards the centre of the crater. Vivàra rises out of the Mediterranean as a truncated cone which attains a height of 109 metres and a diameter across its upper rim of about 900 metres. The eastern half of the cone has been broken down and the sea now fills the circular crater. The waves and rains have cut many sections of the rocks, and thus the structure of the old volcano has been admirably dissected. All students of vulcanology will welcome these memoirs and hope that they may be regarded as the precursors of a long series in which the volcanic history of Southern Italy will be thoroughly elucidated. ARCH. GEIKIE.

AGRICULTURE IN NEW SOUTH WALES.

THE *Agricultural Gazette* of New South Wales has ushered in the century, and, at the same time, marked the consummation of an Australian Commonwealth, by issuing a special federal edition. The history of the agricultural development of the Colony is dealt within most interesting fashion by the chief inspector of agriculture, Mr. W. S. Campbell, who, in the hundred and thirteen pages that he appropriates, unfolds a fascinating tale of the early struggles and final success of this offspring of Great Britain, whose birth dates from the year 1788.

In the section devoted to chemistry in relation to agriculture a considerable feature is made of the value to the agriculturist of soil-analysis. Expert advice in the treatment of soils is said to be much sought after by the farmers of New South Wales, and a typical report on a poor soil is inserted with the view of showing the form that the information takes. The results of the physical and chemical tests are first tabulated, and from these the soil specialist formulates the following recommendations:—"This is a very sour soil, low in plant-food, and only moderately supplied with humus. Its retentive power for water is low, consequently its power of resisting drought. It will not give the best results till sweetened and brought into good condition. The treatment recommended is, first, liming at the rate of about one ton per acre. This will sweeten the soil, and supply lime in which the soil is deficient. Then a quick-growing crop, such as vetches, lupins, cow-pea, &c., should be grown and ploughed under when just maturing. This will supply vegetable matter, improve the texture, and supply nitrogen, in all of which essentials the soil is weak. After this treatment the soil should be able, with proper manuring, to grow any of the ordinary fruits suitable to the district, such as are mentioned in your letter. Peaches and stone fruit should do very well, as well as any vegetables. With regard to the most suitable manuring, this should be on the lines recommended in the attached departmental pamphlet, 'Formulæ for Fertilisers,' which gives the manuring required for the different crops in average soil. In your case the quantities recommended may be somewhat increased. I would particularly impress upon you, (1) That this report is intended to be merely suggestive, and must be followed up by careful experiments on your own part; (2) . . . . (3) That you should impart to your neighbours any information you may gain from this report as freely as it is given to you; (4) That you should communicate regularly with the Department as to the results of your experiments, for we have special facilities for advising you as to the best manures for your special needs, and the cheapest form in which you can get the same."

This typical report is reprinted almost in full in order to show what the Department of Agriculture of New South Wales professes to be able to do in one section of the farmer's business, namely, the management of his soil. Experience in other countries has shown that advice given in the light of laboratory tests on soil is apt to be rather uncertain in its results, but in Australia science has, in this respect, it is said, been very useful to farmers. The practice of liming in that country seems to vary considerably from what holds in England. Where sourness in soil is the trouble an English farmer would consider a dressing of five tons of lime per acre none too much, but in New South Wales one ton is recommended as the maximum dose, to be repeated, if need be, a few years later.

Not the least interesting section of this federal number is that which treats of agricultural education. Technical instruction in agriculture appears to be eminently practical, and it is noted with satisfaction "that among the large number of young people so trained there are to be found so great a proportion who have achieved signal success upon farms and orchards of their own." The curriculum at the Hawkesbury College is almost rigorous in its thoroughness. The students who are on dairy duty turn out at 4.15 a.m., and are probably ready for their breakfast, which is served at seven. The sixty-five horses and mules that cultivate the College farm of 1100 acres demand the attention of another "gang" of students, whose day's work does not close till 8 p.m. Hard manual work does not appear to discourage the young farmer of New South Wales in his pursuit of knowledge, the present accommodation of the College being inadequate to meet the demands for admission. Some illustrations of the practical character of the education are culled from the interesting volume before us, which reflects a colonial vitality most gratifying to the mother-country.

CLIMATE AND TIME AND MARS.

THE astronomical theory of an Ice Age, of which the foundation is attributed to Adhémar, has been the subject of much discussion. Its laborious exposition by Dr. Croll has been justly considered a work of great merit, but it may be said to have proved more interesting as a speculation than convincing as an argument. The adequacy of the theory to explain all that is required of it is a highly controversial matter, and was debated with no little heat in the columns of this journal in 1895-6. Consequently it is desirable to state that this note is written from the point of view of qualified belief in the argument as expounded by Sir R. Ball.

The contribution of astronomy to the data of the problem can be very easily stated. Let us consider the northern hemisphere of a planet, the eccentricity of whose orbit, e, is sensible, but so small that only its first power need be taken into account. In the first place the ratio of the total solar radiation received in summer and winter is $1+a : 1-a$, where $a = 2 \sin \omega/\pi$, ω being the obliquity of the equator to the orbit. This is the law discovered by Wiener, and in the case of the earth $a = \cdot 25$. The ratio of the duration of summer and winter, *i.e.* of the periods between the equinoxes, is $1+b : 1-b$, where $b = 4e \sin \lambda/\pi$, λ being the true anomaly of the spring equinox. Hence the ratio of the mean heat received in a given time in summer and winter is $(1+a)/(1+b) : (1-a)/(1-b)$. In the southern hemisphere the corresponding ratio is $(1+a)/(1-b) : (1-a)/(1+b)$. At the present time $b = \cdot 02$, but in circumstances which would cause the earth's eccentricity to reach its maximum value (about $\cdot 0747$), $b = \cdot 09$ when $\lambda = 90°$. Under such conditions, then, the southern winter would undoubtedly be more severe than at present, while the northern winter would be to some extent mitigated. Precession would have the effect of causing this state of things to alternate in the two hemispheres. The argument is perfectly simple and definite, and can only be questioned on the score of degree, not of fact. It thus passes from the domain of astronomy to that of meteorology. Here the ground is very debatable, and Mr. Culverwell's discussion of the solar radiation incident on individual zones of the earth may be regarded as a decided contribution to a study of this part of the question. But his researches do not seem to be necessarily so conclusive against the astronomical theory of an Ice Age as this author supposes. For the present purpose, however, enough has been said as to the application of the theory to our own planet.

The conditions which hold in the case of Mars resemble in a remarkable manner those which hold in the case of the earth, except in one particular. The eccentricity is ·0933, and hence $b = \cdot 11$. The constant $a = \cdot 27$. These values of a and b apparently afford an excellent example of the conditions required by the theory for a glacial epoch in the southern hemisphere of Mars. It would be illogical to compare the state of corresponding regions on the earth and on Mars, because the concomitant circumstances cannot be expected to be the same. But it is reasonable to suppose that in corresponding seasons the latter planet should show different phenomena in the two hemispheres. As an index of these variations we naturally look to the polar caps, the size of which is known to vary greatly with the seasons. The results to be expected are of this kind:

Hemisphere.	Season.	Duration.	Climate.	Size of Cap.
N	Summer	Long	Cool	Min.
N	Winter	Short	Mild	Lesser Max.
S	Summer	Short	Hot	Min.
S	Winter	Long	Cold	Greater Max.

The amount of heat during summer in either case being the same, there is room for question as to the relative size of the two minima. But it seems clear that the radiation incident on the southern hemisphere will be transformed into heat at a higher temperature than in the northern. According to the laws of thermodynamics it should, therefore, be more effective in the south. The total energy received is the same, but the available energy is greater. Or the matter may be considered differently. It is quite conceivable that during the long cool summer the temperature would not rise above the melting point of ice or whatever substance is in question, while it would be otherwise during the short hot summer. An approach to this condition would lead us to expect the more pronounced minimum in the southern hemisphere.

To compare the suggestions of theory with the facts of observation, we can turn to a recent paper on the subject by Mr. Lowell.[1] He concludes that the caps are composed of ice and not carbonic acid, on account of the difficulty of obtaining the latter substance in a liquid form, a state which he considers proved by observation to exist on Mars. He expresses a belief that the Martian sky is cloudless during the day and that the surface of the planet is protected by cloud at night. It must be confessed that the regularity of transition at sunrise and sunset from one condition to the other almost surpasses our belief and tends to discredit the deductions from the study of projections upon the terminator. Mr. Lowell then considers the evidence of the polar caps. The result is to confirm the expectations formed above, and the conclusion is perhaps the more convincing because the writer seems to find the phenomena surprising. And this point is rather important, for the evidence as to the maxima is not so complete as could be desired. It is to be hoped that Mr. Lowell's examination of this part of the question will lead to the acquisition of more complete and satisfactory evidence.

With regard to the minima, Mr. Lowell does not give the simple explanation suggested above, but attributes the phenomena observed to a deficiency of precipitation. In fact, he professes to prove that "as the precipitation increases a time must come when the southern minimum will actually exceed the northern one in size, *and do so more and more, indefinitely*." As no physical principle is invoked to account for this result, it would seem to be based on assumption. Examination shows that the assumptions tacitly involved are (1) that the maximum of each cap is increased in the *same* ratio, (2) that the amount melted at each cap remains exactly the same as before. It would then follow that in each hemisphere the rate of proportionate growth of the minimum would exceed that of the maximum. We now introduce the observed fact that the ratio of maximum to minimum is greater in the southern hemisphere. This, added to the foregoing, is necessary and sufficient to prove that the rate of proportionate growth of the minimum is greater in the southern than in the northern hemisphere. But the observed fact employed might equally well have been stated in this form: comparing the southern with the northern hemisphere, the ratio of the minima does not exceed the ratio of the maxima; and by assumption (1) the latter is constant. Hence, even on the assumptions the words italicised in the above quotation do not appear justified. The southern minimum may tend towards a relative increase, but there is a limit to the increase. The general idea is perhaps suggestive, but the second assumption involved must be considered highly improbable, and without it the whole theory fails.

At the end of the paper Mr. Lowell turns his attention to the eccentric position of the southern cap. He declines to believe that this well-known peculiarity is due to local elevation, but, on the contrary, attributes it to a region of depression, where the cap has acquired an exceptional thickness. The phenomenon is a very curious one, but speculation as to its origin has probably not much value.

[1] "Mars on Glacial Epochs," by Percival Lowell: *Proceedings* of the American Philosophical Society, Nov. 16, 1900.

THE TELAUTOGRAPH.

IN an article on "Electric Signalling" which appeared recently in these columns (vol. lxiv, p. 6) we referred to the writing telegraph invented by Mr. Foster Ritchie. We have since had an opportunity of examining the instrument and seeing it at work, and are enabled to give a full description of it. The problem of devising an apparatus which should telegraphically transmit the actual handwriting or drawing of the person sending the message is one which has attracted a number of inventors. The difficulties to be overcome are, however, numerous, and in consequence up to the present no really satisfactory instrument has been invented. These difficulties seem to have been mastered in Mr. Ritchie's telautograph in a very ingenious manner, and the instrument is one which should prove thoroughly trustworthy and serviceable. Although it is not to be expected that the telautograph will replace ordinary telegraphic apparatus to any very marked extent, seeing that the speed of signalling is necessarily limited, yet there are numerous cases in which it should be of use. To give only one example, there are many persons possessing private telephone lines who would gladly supplement them with an instrument of this kind by which written instructions can be sent whether there is any one present to receive them or not. Other cases of like kind will doubtless occur to the reader.

One of the chief merits of the Ritchie telautograph lies in the fact that only two wires are needed to connect the transmitting and receiving instruments; these are connected as a single loop earthed at each end, thus providing three distinct circuits since currents can be sent through either of the two wires to return by earth or can be sent through one wire to return by the other. The general principles of the apparatus will be understood from Figs. 1 and 2. Fig. 1 is from a photograph of the instrument with the cover and paper removed in order to show the working parts. It will be seen from this photograph that the complete apparatus consists both of a transmitting instrument, fixed on the horizontal baseboard, and a receiving instrument, supported on the four upright pillars. Fig. 2 is a diagram of the connections, only the principal connections being shown in order to avoid a multiplicity of lines.

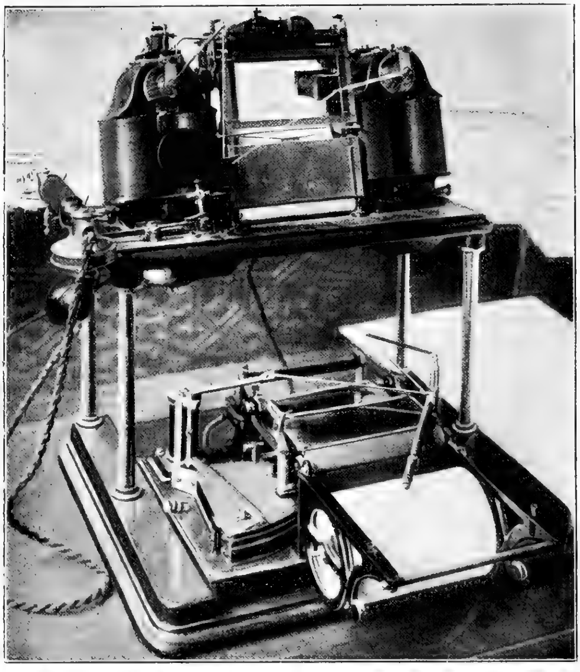


FIG. 1.—General view of the Telautograph.

When the operator wishes to send a message he takes up the transmitting pencil, A, and with the point shifts to the left the catch C. This operation actuates a grip which shifts the paper forward at both ends of the line, thus bringing up a clean piece to write upon, and also connects up the transmitting and disconnects the receiving apparatus at the home end. At the same time, it reverses the connections of one of the sets of batteries, two sets of which are used, one at each end of the line, which are normally connected in opposition so that when the connections of one set are reversed by shifting the catch C they are connected in series. The operator now proceeds to write on the transmitting paper: the pencil, A, is connected to two sets of levers, LL, which actuate the sliding contacts of two rheostats, RR′; these rheostats are connected one in series with each of the two lines, R in the line EWWE′, and R′ in the line EW′W′E′. As the resistances of the rheostats are varied by the motion of the sliding contacts corresponding to the motion of the pencil, A, the currents in the two lines will vary. These currents pass through and deflect the moving coils of two galvanometers of the d'Arsonval type, G, G′, in the receiving instrument; these coils are connected by two sets of levers, L′L′, to the receiving pen, B. It will thus be seen that the position of the pen B is controlled by the deflections of the two galvanometers, which are in their turn dependent on the position of the transmitting pencil A: the pen will therefore exactly follow in its motions the movements of the pencil and will consequently repeat on the paper at the receiving end the drawing made on that at the transmitting end. The currents, after traversing the coils of G and G′, pass through the relays D and D′ (the use of which will be explained presently) and then return by earth.

From what has been said so far it is obvious that the receiving pen will copy the movements of the pencil A, whether the pencil is being used to write on the paper or merely being moved about above it. It is necessary to prevent the pen B from making marks on the paper except when A is actually writing on the paper at the transmitting end. This is effected in the following ingenious manner. A small induction coil at the transmitting end has its primary circuit, P, completed through a contact, M, attached to the desk on which the writing paper rests: the terminals of the secondary coil, S, are connected to the line wires, W,W′, and the circuit is completed at the receiving end through the relay H and the condenser K′. Intermittent currents are thus sent round the circuit SWHW′S and, actuating the relay H, put in action a pen lifting magnet (not shown in the diagram) which raises the bar F and holds the pen B off the paper. When the operator starts writing the pressure on the paper breaks the contact at M and thus stops the vibratory currents; the relay H is released and the bar F falls back, thus allowing the pen to come into contact with the receiving paper. It will be noticed that the vibratory currents are superimposed on the ordinary line currents, but they are prevented from affecting the receiving pen by the self-induction of the galvanometer circuit, whilst at the same time the line currents are prevented from passing through the relay H by the condensers K and K′. A small amount of the intermittent current does pass through the galvanometer coils, but this is, as a matter of fact, advantageous, as it prevents, by the slight vibration it produces, any tendency to sticking.

When the writer has filled up the strip of paper he again shifts the clutch C and this moves forward the paper at his end and also, through the operation of the relay D, shifts that at the receiving end. At the same time the pen B returns to the ink bath and takes a fresh supply of ink: the ink bath is not shown in Fig. 2, but can be seen, with the pen resting in it, in Fig. 1 in front of the

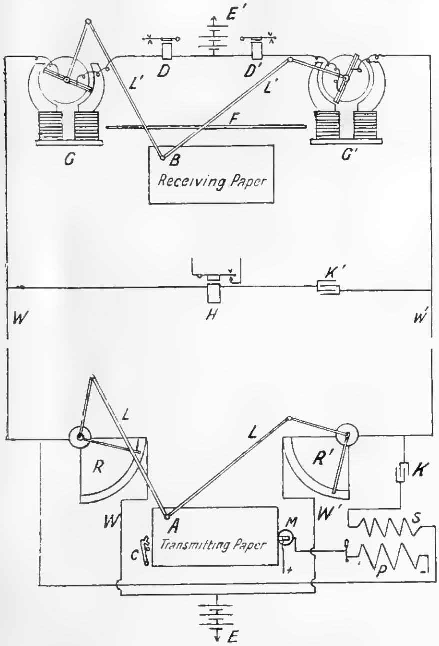


FIG. 2.—Diagram of telautograph connections.

galvanometer on the left. The pen, which is shaped like a small pipe, the bowl being a reservoir for the ink, holds sufficient ink to cover the amount of paper exposed at one time. The relay D′ controls a local bell circuit and is used for ringing up. Neither the connections of this bell circuit nor of the paper shifting magnet are shown in Fig. 2, the relays only being shown in order to avoid unnecessary complication.

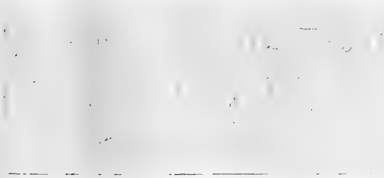


FIG. 3.—Transmitted message.

A specimen of the writing transmitted by the telautograph is shown in Figs. 3 and 4. Fig. 3 shows the words as written in pencil at the transmitting end, and Fig. 4 as received at the far end. These words were transmitted over an artificial line nearly 300 miles long; it will be seen that although the writing is somewhat distorted it does not lose its character and is indeed a very fair reproduction. The words were written on the first telautograph that Mr. Ritchie has constructed; in future instruments it is to be expected that the reproduction will be even more accurate, as several improvements in detail have been introduced, but it must be admitted that the performance of the present apparatus leaves little to be desired. There is no difficulty in writing, in spite of the pencil being attached to the rheostats and having to move

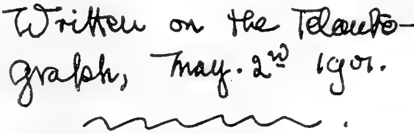


FIG. 4—Received message.

them; everything seems to move very freely and it is almost as easy to write as with an ordinary pen. Moreover, as long as the paper is not shifted, the writer can go back and make alterations and additions with perfect accuracy.

We are much indebted to the Telautograph Co. for allowing us to examine the instrument, and to Mr. Foster Ritchie for very kindly explaining to us the details of its construction.

NOTES.

MR. BALFOUR has often pleaded for the increase of facilities for scientific research, and has pointed out how, in this respect, our country compares unfavourably with some others. The festival dinner of the Medical Graduates' College and Polyclinic, on May 22, gave him another opportunity to remind the public of existing deficiencies and the duties of wealthy citizens towards them. As purely scientific research can never be self-supporting, and as, moreover, every addition to knowledge is of value, it has peculiar claims upon the public and the nation. How small, comparatively, is the response to these claims is known to all of us. Here science is tolerated but it cannot be said to be encouraged; and this because the people who have the means to further scientific interests are not in sympathy with them. The State leaves the adequate provision for scientific research to private benevolence, but liberal benefactions are few and far between, so work which would be done here if means were available is left to other nations. Many men of science spend their private incomes to carry on investigations which elsewhere would be afforded generous support, and they often have to leave work unfinished because such assistance is not forthcoming. "I do not believe," said Mr. Balfour, "that any man who looks round the equipment of our universities or medical schools, or other places of education, can honestly say in his heart that we have done enough to equip research with all the costly armoury which research must have in these modern days. We, the richest country in the world, lag behind Germany, France, Switzerland, and Italy. Is it not disgraceful? Are we too poor or are we too stupid? Do we lack the imagination required to show what these apparently remote and abstract studies do for the happiness of mankind? We can appreciate that which obviously and directly ministers to human advancement and facility, but seem, somehow or another, to be deficient in that higher form of imagination, in that longer sight, which sees in studies which have no obvious, necessary or immediate result the foundation of the knowledge which shall give far greater happiness to mankind than any immediate, material, industrial advancement can possibly do; and I fear, and greatly fear, that, lacking th imagination, we have allowed ourselves to lag in the glorious race run now by civilised countries in pursuit of knowledge, and we have permitted ourselves to far too large an extent to depend upon others for those additions to our knowledge which surely we might have made for ourselves." Unfortunately there seems little hope of improvement in this depressing condition of affairs. We would ask, however, how comes it that the members of the Government, knowing the position of things and expressing belief in the salvation of the nation through science, neglects to take up the responsibilities which are overlooked by private benefactors? If we have to look to private sources for the provision for scientific research furnished by the State in other countries, the outlook is not encouraging to contemplate. We lag behind other nations now; and, applying the natural law to the political world, steady progress in the growth of scientific knowledge will only be possible when the conditions for development are made more favourable than they are at present.

THE annual visitation of the Royal Observatory, Greenwich, will be held on Saturday, June 1.

AT the annual meeting of the Institution of Electrical Engineers to be held this evening, an illuminated address received from the American Institute of Electrical Engineers will be presented. The address has been sent as an expression of thanks for courtesies extended to members of the American Institute during their visit to London last year, and in connection with the joint meeting at Paris. It is a pleasant token of the cordial relationship existing between British and American electrical engineers, and the feeling which prompted the resolutions embodied in the address will doubtless be much appreciated.

THE success of the visit of members of the Institution of Electrical Engineers to Switzerland in 1899 has led to arrangements being made for a visit to Germany next month. There will be three parties, one visiting Berlin only, another visiting Berlin and Dresden, and a third visiting Berlin, Dresden, Nüremberg, Frankfurt-a-Main and other places. The whole party will leave London on Saturday, June 22, and upon their arrival at Hanover on Sunday evening will be entertained at dinner by the town authorities. At Berlin, in addition to visits to works, a visit will be paid to the Technical High School, where Prof. Slaby will show the college to the members. Several dinners and receptions will be given to the visitors in Berlin and elsewhere by electro-technical societies and other bodies. Ladies may accompany the members, and the visit promises to be pleasant and profitable to all who take part in it.

As may well be imagined from the wealth of blossoms now to be seen in our gardens, the flowers exhibited at the Temple Show of the Royal Horticultural Society last week were very fine. Those, however, who looked for novelties met, for the most part, with disappointment. There was nothing of startling popular interest or of extraordinary scientific significance, while new garden plants were not very notable and seemed few and far between. Mr. H. J. Elwes, F.R.S., showed *Cypripedium guttàta* in bloom, a plant which he obtained a year or two ago on the Altai Mountains. Its habitat was in a dense forest that was almost impenetrable. The markings on the perianth were of a very pleasing red, and the specimens did credit to their treatment, which included their being kept on ice during the winter. The series of insectivorous plants hard by, sent by Mr. A. J. Bruce, of Chorlton-cum-Hardy, was very fine, and the Sarracenias may be particularly mentioned. One flippant visitor likened the leaves of some to steamboat ventilators which had been twisted. A similar collection belonging to Mr. R. R. J. Measures was also worthy of careful examination. Very suggestive of the balance that must be maintained between roots and foliage were the trees artificially dwarfed by the Japanese. These were quite plentiful, being exhibited by professional and amateur horticulturists alike. Here the skilful grower has so limited the root system and so cunningly reduced the number of leaves that, practically speaking, only sufficient food is manufactured to maintain the plant in health, there being hardly any surplus to provide the material necessary if growth is to continue. It does continue, but so slowly that we may not get a tree more than two feet high after three hundred years have passed over its head.

IN recent years there has been much progress in the processes of preparing sulphur for use in the prevention of diseases of plants, and the demand, in consequence, has greatly increased. The methods actually employed for estimating the quality of these preparations are, however, now out of date and leave much to be desired, especially as regards the mixtures of sulphur and copper sulphate. With the view to encourage special studies on this subject, the Federation of the Agricultural Unions of Italy, together with the Agricultural Unions of Padua and Florence, has therefore decided to open an International Prize Competition for the sum of 1000 francs in gold, to be awarded to the person who discovers and makes public the best method for obtaining exact and trustworthy results in the determination of the quality of flowers of sulphur and of mixtures of sulphur and copper sulphate. Competitors must send in their papers in a sealed envelope to the head office of the Federation (Ufficio direttivo della Federazione italiana dei Consorzi agrari, Piacenza, Italy) before March 1, 1902. The papers will be examined by a special commission to be named by the Reale Accademia dei Lincei, Rome.

ALL those who knew Mr. Anthony Wilkin will regret to learn that he died of dysentery in Cairo, in the twenty-fourth year of his age, on May 17. In his early undergraduate days Wilkin published a bright little book, "On the Nile with a Camera," and while still an undergraduate he accompanied the Cambridge Anthropological Expedition to Torres Straits and New Guinea. His historical and sociological studies in Cambridge prepared him for the investigations he made on the land tenure, laws of inheritance and other social questions. He also made notes on the various kinds of habitations in the districts he visited. All these observations will be duly published in the Reports of the Expedition. Immediately after his first winter's digging in Egypt with Prof. Flinders Petrie, he went with Mr. D. Randall-Maciver to Algeria to study the problem of the supposed relationship, actual or cultural, of the Berbers with the ancient Egyptians. An interesting exhibition of the objects then collected was displayed at the Anthropological Institute in the summer, and later on in the year Wilkin published a well-written and richly illustrated popular account of their experiences entitled "Among the Berbers of Algeria." Quite recently the scientific results were published in a sumptuously illustrated joint work entitled "Lybian Notes." Mr. Wilkin was an enthusiastic traveller and was projecting important schemes for future work. There is little doubt that had he lived he would have distinguished himself as a thoroughly trained field-ethnologist and scientific explorer.

THE National Home-Reading Union has arranged to hold a summer meeting at Winchester on June 22–29, when lectures will be given on various aspects of King Alfred, whose millenary will be celebrated this year. In connection with the meeting, Mr. J. E. Marr, F.R.S., will give four lectures on "The Application of Geology to Scenery," a secondary purpose of the meeting being the study of the geology and botany of the district as well as its archæology.

THE Simla correspondent of the *Times* reports that the Secretary of State has sanctioned a scheme for an ethnographical survey of British India in accordance with the suggestions made in 1900 by the British Association. The work will be done by civil officers in addition to their own duties, Mr. Risley being appointed director of ethnography. The annual expenditure will be 40,000 rupees, and the total cost is estimated at 1½ lakhs, excluding the cost of printing. The Government hope that ethnologists and scientific societies in Europe and America will assist the director with advice, refer to him the points they desire to make the subject of inquiry in India, and supply him with copies of publications bearing on the researches about to be undertaken during the next four years.

THE third series of trials of motor vehicles for heavy traffic is arranged to take place in Liverpool and neighbourhood during the five days commencing Monday, June 3. Referring to the results of previous trials, the *Times* points out that in 1898 the wheels of the four competing vehicles proved structurally defective when subjected to the hammering action of granite sets and cobble sets, whilst minor troubles arose in respect to adhesion and with the condensers, &c. The second trials, which took place in 1899, provided satisfactory evidence that the tire and adhesion difficulties had been overcome, for none of the wheels gave the smallest trouble, and five out of six of the competing vehicles in the hill-climbing tests successfully surmounted gradients varying between one in nine and one in thirteen with as heavy a load as six and a half tons. Yet the judges found that the strength of these vehicles was "below what is compatible with a satisfactory life in commercial work"—a state of things which they attributed mainly to "the difficulties imposed by meeting the limit of three tons tare under the Locomotives on Highways Act, 1896." In order to see whether manufacturers could improve their designs so as to produce an efficient commercial vehicle under the three-ton limit of tare, the Liverpool Self-propelled Traffic Association has allowed an interval of two years between the second trials and the third series now about to be held. For the coming trials an entry of thirteen vehicles has been secured, which will compete in four classes. Class A is for comparatively light vehicles propelled by internal combustion engines using deodorised naphtha or petroleum spirit, and carrying a load of only one and a half tons. The vehicles entered under the other three classes are all steam propelled, electricity being again unrepresented. The steam waggons, however, comprise a great variety of design, including several boilers of the flash, or instantaneous generation, type.

THE Report of the Council of the Royal Agricultural Society of England, read at the annual meeting on Wednesday of last week, was not an altogether satisfactory one. The total number of governors and members is more than ten thousand, but since last year there has been a nominal reduction of 633—which includes 314 voluntary resignations. A few of these have withdrawn from the Society on account of the decision of the Council to discontinue the annual migratory shows after 1902, because of the serious losses the last three have involved. The show this year will be held at Cardiff, from June 26 to July 1, and in 1902 the last of the series will be held at Carlisle. These migratory shows will be superseded by a permanent showyard at Twyford Abbey—a few miles out of London. For the prizes of 40*l.* and 20*l.*, offered by the Society for portable oil engines, eight entries have been received, the trials of which will take place in the Cardiff showyard in the week previous to the show. For the similar prizes offered for agricultural locomotive engines, no entry has been received; and for the prize of 15*l.* offered by the Society for the best small ice-making plant suitable for a dairy, only one entry has been made. The council report that at the Woburn Experimental Farm the feeding experiments have shown that sheep fatten perfectly well, and without any drawbacks, when fed on mangels instead of swedes. Gorse has been proved to be a useful food, but the results were slightly inferior to those obtained by the use of hay. Progress is being made with the usual field experiments and with the investigations of various agricultural problems, including the eradication of farm weeds. At the pot-culture station experiments are being continued in connection with Hills' bequest. Much attention has been given to the value of seeds, and reports have been supplied to members of the Society in regard to the purity and germination of 116 samples of different seeds. A disease in the cherry orchards of Kent, which has seriously affected the cherry crop, has been investigated by the Society's consulting botanist, and a description and figures of the disease have been printed as a leaflet and extensively circulated in Kent and other fruit-growing districts. The Zoological Department has been chiefly concerned during the past six months with pests injurious to stored produce and with such insects as are troublesome all the year round. Some of the more important applications have had reference to forestry, and advice has been given with regard to various insects attacking plantations of coniferous and other trees.

A DISASTROUS explosion occurred at the Universal Colliery, situated at the top of Aber Valley, a few miles from Caerphilly, on Friday last, no less than eighty-three men having perished through the accident. Mr. Dyer Lewis, assistant inspector of mines, is reported by the *Times* to have said that there was no longer any doubt that the explosion was caused by coal dust, adding that the long continuance of the north-east wind, which practically prevailed for three weeks, might probably have had the effect of drying up the air passing through the workings and thus have caused the coal dust to become drier.

WE understand that the Admiralty is proceeding energetically with the fitting of wireless telegraphy to the ships of the British Navy. The "Apps-Newton" coil has been adopted as the standard pattern, and a large number of coils and transmitters have been ordered.

A COMPLETE installation of Marconi's wireless telegraphy specially suitable for signalling purposes as used in the Navy has been fitted on board the Elder, Dempster Beaver liner *Lake Champlain*. This installation is the first which has been fitted on any of the Atlantic liners sailing from Liverpool. The *Lake Champlain* left the Mersey for Halifax last Tuesday with more than 1000 passengers, and arrangements were made to establish communication between the vessel and the Marconi wireless telegraph station at Holyhead. The *Times* states that at 9.37 p.m., when off the Skerries, communication was obtained with the Holyhead station, the vessel being then thirteen miles distant. Numerous telegrams were then forwarded from passengers to friends in all parts of the United Kingdom, each message being acknowledged by the receiving operator. Constant communication with the station was continued until 1 a.m., the vessel being then thirty-seven miles distant. Communication was established with the Marconi station at Rosslare, and at 4.30 a.m. a fresh batch of telegrams was forwarded, notifying the vessel's arrival off the Tuskar light to the owners, Messrs. Elder, Dempster and Co. The position of the ship was nineteen miles from Rosslare telegraph station. The last telegram was forwarded at 7.30 a.m., at a distance of nearly thirty miles from Rosslare.

OUR paragraph directing attention to the proposal to erect a memorial to the late Right Hon. Prof. Huxley in Ealing has elicited one noteworthy response. The contributor, who gives neither name nor address, begins his covering letter: "In the current issue of NATURE" (which presumably he had seen at a free library) "the reader is informed of a movement on foot in Ealing for a memorial to the memory of Huxley. With gladness I hasten to contribute my mite," and concludes an able, if lengthy, epistle as follows: "I enclose a postal order for 1*s.*

as some *little* help towards the memorial. Even now I am giving beyond my means, as I am merely a casual dock labourer, living from hand to mouth, and often hardly able to make both ends meet. But I never let my mind get rusty, and from my boyhood have had a keen partiality for 'Nature's leading lights' and their works. Among the brightest of these, and of whom any nation might be justly proud, flashes out Thomas Henry Huxley."

THE *Procès-verbaux* of the meeting of the International Committee of Weights and Measures at Paris in September last have been received. The Committee had under their consideration the reports of the director on the work of their bureau for 1899-1900, by which reports it would appear that besides the ordinary verification work of the bureau (standard metres, kilograms and thermometers for various Governments, Universities and scientific authorities) important researches have been carried out as to alloys of nickel and steel (Dr. Guillaume); as to comparisons of platinum and hydrogen thermometers (Dr. Chappuis and Dr. Harker), and the determination of the mass of a cubic-decimetre of distilled water. Dr. Benoit reports that the latter mass may be taken as equivalent to 999·936 grammes; but it does not appear that the true value of a cubic-inch of water is to be derived from the cubic-decimetre. The best ordinary alloy for measures of length (as bars, line-measures, survey ribands, &c.) appears from Dr. Benoit's report to be one of 64·3 per cent. of steel and 35·7 per cent. of nickel.

We note that the Committee referred to in the foregoing note propose to take up the vexed question of an international series of sizes of screw-threads, based on the millimetre. The annual expenditure of the Committee amounts at present to 75,000 francs, but it would appear that at the general conference to be held at Paris in October next, under the Metric Convention 1875, a proposal is to be made to raise the annual budget to 100,000 francs, at which sum it was formerly fixed, so as to meet necessary expenditure on the instrumental equipment and maintenance of the bureau. Towards this annual expenditure each High Contracting State contributes a sum based on its population, and on the extent to which the metric system may be in force within each country; Great Britain contributes about 5000 francs. Some effort appears to have been made in September last by the Decimal Association (London) to induce the Committee to lay before the French Government a proposition to invite the attention of the Governments of Great Britain, Russia and the United States to the desirability of making the metric system compulsory in these countries; but the Committee do not appear to have approached the French Government on this delicate proposition. From the communications addressed to the Committee by Prof. A. Michelson (Chicago), Mr. Chaney and Prof. Mendeléeff, it seems that the metric system is, however, making way in the three great countries above mentioned.

Die Umschau contains a short account of Hoffmann's model flying-machine. The peculiarity of this model (which weighs 3½ kilogrammes) is that it is supported on three long legs, by the aid of which it runs on wheels on a track or on the ground till it has gained sufficient velocity to rise in the air, when the legs fold up automatically and the model flies somewhat after the manner of a stork. It is claimed that such an arrangement applied to a man-lifting machine would obviate the difficulties connected with the starting and landing.

WE have received a copy of the magnetical, meteorological and seismological observations made at the Government Observatory, Bombay, for the years 1898 and 1899, under the direction of Mr. N. A. F. Moos, which extends the record of this important series to a period of fifty-four years. The observatory is very completely equipped both with ordinary and self-recording instruments, the standards being read five times daily, commencing with 6h. a.m. A Dines' pressure tube anemometer, probably the most satisfactory instrument for recording the varying strength of the gust of wind, was erected in February 1897, and a Milne's seismograph in September 1898. In addition to the tables of results obtained from the automatic instruments and from the direct eye observations, the volume contains the following valuable appendices:—(*a*) Hourly means of the magnetic elements, as determined from quiet days, for the years 1894-9; (*b*) Notes on the harmonic analysis of temperature and pressure for 1876-1895, with plates; (*c*) Hourly and daily normals of the several meteorological elements, and their variations expressed by Bessel's formula.

WE have received from Mr. J. Baxendell, meteorologist to the Southport Corporation, the report and results of observations at the Fernley Observatory and allied stations for the year 1900. With a small amount of means at their disposal, Mr. Baxendell and his staff perform a large amount of very useful work, much of it of an experimental kind, in addition to the routine work of a well-equipped observatory. Special attention is given to the results of various anemometers of the most modern construction, and it is stated that the highest pressure yet recorded by a pressure plate anemometer is 20·7 lbs. per square foot. Another useful investigation is the comparison between the amounts of bright sunshine recorded by the Campbell-Stokes and the Jordan sunshine recorders. The monthly percentages of three years show that the latter instrument records somewhat higher values, except in the winter months. The falling off at this period appears to be traceable to increased relative humidity and to greater prevalence of fog. The report contains useful tables of rainfall and sunshine values at a considerable number of stations—mostly sea-side resorts.

THE third sheet of the North Atlantic and Mediterranean Pilot Charts published by the Meteorological Council is devoted to the month of June. Being the midsummer month, the atmospheric conditions are usually of the quietest description, the region in which the gale frequency exceeds 10 per cent. being now limited to the far north, beyond the 55th parallel. Disturbances of a cyclonic character are, however, of frequent occurrence on the more frequented shipping routes, but as most of them are of slight intensity severe gales seldom result. At this season, the conditions begin to assume a less steady appearance in the doldrums off the African coast, developing later into conditions which give birth to hurricanes moving westward towards the West Indies. Similar local features of the winds on the American coasts and in the Mediterranean are dealt with. Fog is very frequent, above 50 per cent., from the coast of Maine eastward across the Newfoundland Banks, and even the 10 per cent. frequency extends, with only a narrow break in about 20° W., from Sandy Hook to the Severn and the Bay of Biscay. Fogs as dense and as wet as those of the Banks now visit the Straits of Gibraltar, but, fortunately, they last only a few hours. With the exception of a berg and some field ice sighted on March 16 last, there has been no report of ice at sea this year, though at various times the pack in some of the Newfoundland and Cape Breton bays has been driven out by high winds. The eastward drift of the Gulf Stream, which the May chart showed was interrupted in 47° N. 27° W., continues across the ocean to our south-western shores in June, there being a good deal of easterly and north-easterly current in the space between Ireland and the north-west of Spain. The equatorial counter-current of the doldrums is met with as a prevailing set as far west as the 42nd meridian; the equatorial west-going current attains a high velocity, 60 to 85 miles a day; and in Florida Strait the Gulf Stream may reach 100 miles in a day. In every way the June chart is as interesting and valuable as its predecessors.

WE have received from Messrs. Friedländer the second part of their valuable *International Zoologist's Directory*, containing the emendations and additions necessary to bring the issue of 1895 up to date. These emendations include a list of zoologists deceased since that date, as well as a record of all changes of address that could be ascertained. The lists of the staffs of all the more important zoological institutes and museums form a feature of this part; and, so far as we have been able to test it, the work is comprehensive and singularly free from errors.

THE only original article in the May issue of the *Zoologist* is a continuation of Mr. E. Selous' observations on the habits of the great crested grebe. The author expended a vast amount of time and trouble in watching a pair of these beautiful birds during the breeding season. Attention is drawn to the circumstance that the male bird takes a considerable share in the duties of incubation; and it is suggested that it likewise constructs a platform for its own use in the neighbourhood of the nest. This leads the author to formulate a theory as to the origin of the "runs" of the Australian bower-birds, which, in opposition to the views of other naturalists, he regards as specially modified nests.

DR. A. APPELLÖF sends us the first fasciculus of a new work under his editorship, entitled "Meeresfauna von Bergen," now in course of publication by the Bergen Museum. The systematic investigation of the marine fauna of Bergen was commenced many years ago, and since the establishment there of a marine biological station has advanced with great rapidity. Many interesting problems are connected with the fauna of the sea of this district, which is now to be described in considerable detail. The work will include a map showing the different faunal zones and dredging stations. In the present fasciculus Mr. K. Bonnevie, of Christiania, treats of the hydroid polyps, Dr. R. Hartmeyer of the holosomatous ascidians, and Mr. E. Arnesen of the calcareous sponges. The first two subjects are illustrated with plates or figures, and the names of the authors afford a sufficient guarantee of the manner in which each is treated.

WE have received numbers 6 and 7 of the Liverpool Marine Biological Committee's *Memoirs*, both of which maintain the high level of their predecessors. The first of these, by Mr. A. Scott, is devoted to the fish-parasites of the genera Lepeophtheirus and Lernæa. These crustacean (copepod) parasites are almost wholly restricted to portions of the fish they infest which are in direct communication with the exterior, such as the skin itself, the fins, mouth, gill-chamber and gills, nostrils, or even the eye. The full life-history of both the types mentioned is given in considerable detail; and it is shown that while in the former development takes the form of steady progression, in the latter it assumes an equally marked degradation. Indeed, so strange are the phases assumed by Lernæa (as is well shown in the plates with which the memoir is illustrated), that there is little wonder that the older naturalists, when its life-history was still unknown, were puzzled as to its serial position, and failed to recognise its near kinship to the other genus described in the present fasciculus. The second of the two *Memoirs*, by Mr. R. C. Punnett, deals with the genus Lineus, as exemplified by that common British nemertean worm, *L. gesserensis*, notable, if for no other reason, on account of having, in its different phases, received no less than ten generic and thirteen specific titles. Varying between 6 and 20 centimetres in length, and displaying two distinct colour phases, this worm occurs abundantly underneath stones between tide-marks and also in the laminarian zone, frequently occurring in tangled masses. Its distribution is also large, extending from Greenland to Madeira on one side of the Atlantic and to Florida on the other. In addition to a careful and well-illustrated description of its anatomy and life-history, Mr. Punnett furnishes his readers with an elaborate table, showing at a glance the exact systematic position of this curious worm.

THE Summary Report of the Geological Survey of Canada for 1900 has a melancholy interest for geologists owing to the recent death of Dr. G. M. Dawson, the Director. It is a clearly printed work of 203 pages, with a colour-printed map of the Atlin gold-fields, and its price is ten cents. As usual, while due attention is given to the scientific work the practical subjects are treated as exhaustively as possible, and general observations on natural history are included. So many different topics are discussed that it is impossible to give any condensed account of them; suffice it to say that the Yukon district with its gold and coal workings, the coal of British Columbia and Nova Scotia, the lakes of Ontario and New Brunswick, the finding of natural gas in borings in the valley of the Nation river, the anorthosite of Quebec, and numerous other matters are dealt with.

WE have received from Messrs. Merck a pamphlet upon "Tannoform," an antiseptic which has lately been very much employed in veterinary practice. This substance was first prepared about six years ago, and is a condensation product of tannic acid and formaldehyde, its composition being represented by the formula $CH_2\langle {C_{14}H_9O_9 \atop C_{14}H_9O_9}$. Tannoform is a buff-coloured powder and is odourless and almost tasteless. It is insoluble in water, but fairly soluble in alcohol and ether, also in caustic alkalis and ammonia. Formaldehyde is one of the most powerful antiseptics and germicides which we have, but being at the same time a strong irritant it can only be used in very dilute solutions. Tannoform appears to possess all the antiseptic properties of formaldehyde, but is free from its unpleasant smell and irritating action, beside which the well-known astringent properties of tannic acid are also retained. Owing to its anhydrodic action, this substance was at first chiefly employed as a remedy for excessive perspiration of the feet and other parts of the body. Tannoform appears to have been first employed for veterinary purposes in the veterinary college of Berlin, when it was found that, not only could it be employed in place of the unpleasant smelling and expensive iodoform, but that wounds treated with it healed more rapidly than when iodoform was used. In cases of purulent and malodorous wounds, tannoform is said to be very beneficial, because of its antiseptic and deodorising properties. When taken internally, this substance appears to be quite harmless, even when large doses are administered. It has been found of special value in cases of diarrhœa and intestinal catarrh. Most antiseptics carry with them an odour—not usually pleasant—by means of which their presence can be detected. In tannoform we have an odourless and powerful antiseptic.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. T. J. Erroll; a Guinea Baboon (*Cynocephalus sphinx* ♂) from Africa, presented by Mr. C. W. Fowke; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Lord Hindlip; a Guilding's Amazon (*Chrysotis guildingi*) from St. Vincent, presented by the Earl of Crawford and Balcarres; a Woolly Opossum (*Didelphys lanigera*) from Colombia, a Violet-necked Lory (*Eos ricinata*) from Moluccas, a Razor-billed Curassow (*Mitua tuberosa*) from Guiana, deposited; a Demoiselle Crane (*Anthropoides virgo*) from North Africa, two Summer Ducks (*Æx sponsa* ♂ ♂) from North America, two Mandarin Ducks (*Æx galericulata* ♂ ♀) from China, an African Elephant (*Elephas africanus* ♂) from Abyssinia, purchased; a Duke of Bedford's Deer (*Cervus xanthopygius* ♀) a Japanese Deer (*Cervus sika* ♂) a Thar (*Hemitragus jemlaicus* ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JUNE.

June 3. 14h. 4m. to 15h. 13m. Moon occults μ Sagittarii (mag. 4·1).
3. 15h. 6m. to 16h. 12m. Moon occults 15 Sagittarii (mag. 5·6).
4. 9h. Jupiter in conjunction with moon, Jupiter 3° 53′ S.
4. 14h. 49m. to 15h. 59m. Moon occults B.A.C. 6536 (mag. 5·5).
4. 17h. Saturn in conjunction with moon. Saturn 3° 43′ S.
5. 20h. Uranus in opposition to the sun.
7. 0h. Mercury in conjunction with ϵ Geminorum, star 4′ N.
7. 14h. 59m. to 15h. 54m. Moon occults c^1 Capricorni (mag. 5·2).
14. Saturn. Outer minor axis of the outer ring = 17″·58.
15. Venus. Illuminated portion of disc = 0·977, Mars = 0·890
15. 17h. Mercury at greatest elongation, E. 24° 39′.
24. 12h. 2m. Minimum of Algol (β Persei).
25. 7h. 57m. to 9h. 18m. Moon occults B.A.C. 4531 (mag. 5·7).
27. 8h. 51m. Minimum of Algol (β Persei).
28. 9h. 47m. to 11h. 54m. Transit of Jupiter's Sat. IV.
28. 11h. 15m. to 12h. 15m. Moon occults ω^1 Scorpii (mag. 4·1).
28. 11h. 30m. to 12h. 48m. Moon occults ω^2 Scorpii (mag. 4·6).
30. 5h. Jupiter in opposition to the sun.
30. 10h. 4m. to 12h. 21m. Transit of Jupiter's Sat. I. The satellite will be almost centrally superposed on its own shadow.

THE RECENT TOTAL ECLIPSE OF THE SUN.—A further telegram from the *Times* correspondent at Sawahloento, dated May 23 gives a few more particulars respecting the results obtained by the various observers occupying the stations in or near Sumatra. The weather is described as having been moderately good at all these stations—best at Fort de Koch, worst at Solok—thin clouds were present at most of them.

In all eleven camps were formed, comprising one Dutch, two English, four American, one Russian, one French, one Jesuit and one Japanese. Generally partial success is reported from most of the camps, the unfortunate exception being that of Prof. Barnard, who had set up a most elaborate collection of instruments at Solok, the chief being a telescope of 61 feet focal length, with which he hoped to obtain photographs of the corona on plates 40 inches square. Three of the plates show only feeble fragments of the brighter portions of the coronal structure.

It is reported that good photographs of the *flash* spectrum were obtained here, and no names being mentioned we can only surmise that this refers to the spectroscopic party from the Yerkes and United States observatories, who were furnished with powerful spectrographs and established their camp at Fort de Koch, near by, so as to be approximately on the northern edge of the moon's shadow. Mr. Jewell had charge of a number of gratings of large size, both plane and concave, provided with films 36 inches long, intending to pay special attention to the ultra-violet regions of the chromospheric spectrum. Dr. Humphreys also took spectrographic apparatus. Prof. Skinner, in charge of the American party, had cameras to be used in searching for a possible intra-mercurial planet, but no mention is made of the fate of these observations.

The duration of totality at the American station was determined at 5m. 47s. instead of 5m. 42s. as predicted.

In consequence of the unfavourable meteorological conditions, the special investigations depending on the unusually long duration of totality were either unsuccessful or abandoned altogether.

Mr. Dyson, although he had to expose through thin clouds, obtained fairly good large-scale photographs of the corona; the small-scale plates show a considerable number of stars.

Mr. Newall is reported to have obtained good results with a grating spectrograph. Visual observation showed that the brightness of the green coronal ring was very uneven. A series of eight photographs with the polariscopic camera exhibit marked polarisation of the bright portions of the corona, especially in the case of the southern edge of the brightest streamer.

He was also successful in obtaining good photographs of the corona, which shows considerable similarity to that of last year.

The observations made to determine the *rotation* of the corona were unsuccessful.

M. de la Baume Pluvinel, who also observed among the mountains in Sumatra, announces partially successful results.

COMET a (1901).—A circular (No. 44) from the Centralstelle gives the following ephemeris for the new comet:—

Ephemeris for 12h. Berlin Mean Time.

1901.	R.A. h. m. s.		Decl. ° ′
May 24	6 19 16	...	+6 22·9
26	26 16	...	6 49·8
28	32 41	...	7 14·4
30	38 37	...	7 36·9
June 1	44 7	...	7 57·5
3	49 15	...	8 16·4
5	54 5	...	8 33·7
7	6 58 38	...	8 49·5
9	7 2 55	...	9 4·0
11	7 7 1	...	+9 17·3

HISGEN'S VARIABLE, 13 (1900) CYGNI.—At the request of Father Hisgen, Prof. E. C. Pickering has had an examination made of the Harvard plates showing the star, and gives the resulting measures in *Astronomische Nachrichten* (Bd. 155, No. 3712). 181 plates were found covering the region, extending over the period 1887 November 30—1900 September 26.

After plotting the measured magnitudes to a time scale it was found that the star varies with moderate regularity in a period of 218 days. It has a magnitude of about 10·2 at maximum, and 13 or fainter at minimum.

THE PLANET SATURN.

SATURN now passes the meridian in the morning twilight, and is situated about 4° east of the planet Jupiter. The two objects will form an exceedingly interesting couplet in the southern sky during ensuing months, their times of southing and apparent distances being as follows:—

		Jupiter south. h. m		Saturn south. h. m.		Distance. °
June 15	...	13 9	...	13 28	...	5
July 15	...	10 55	...	11 21	...	6
Aug. 15	...	8 41	...	9 11	...	7
Sep. 15	...	6 40	...	7 6	...	6
Oct. 15	...	4 54	...	5 12	...	4
Nov. 15	...	3 14	...	3 19	...	1
Dec. 15	...	1 43	...	1 34	...	2

They will be evening stars during the late summer and in the autumn, but early in December will have approached too near to the sun for further observation. For telescopic scrutiny, the proximity of the two bodies will be found very convenient, but their low altitude of about 15° or 16° when due south will operate very unfavourably upon the character of the images.

It is a matter of common experience that Saturn will satisfactorily bear greater magnifying power than either Mars or Jupiter; but during the ensuing apparition moderate eyepieces will be best. Even with these, definition will be rarely good in latitudes so far north as Greenwich. The rings are now widely open, and their north side will continue to be presented to the earth until 1907. When Saturn is placed above the equator and traversing the zodiac from Pisces to Virgo, we see the southern surface of the rings, and the northern surface when he is below the equator and moving from Virgo to Pisces. The rings are turned edgeways towards us, and are practically invisible when the planet is in Virgo and Pisces.

Well-defined irregular markings are rare on Saturn. Dawes in January 1858 saw a bright spot and Asaph Hall followed a similar marking in December 1877, but it soon grew faint and disappeared. Several transits of the latter object were obtained, and a rotation period of 10h. 14m. 23·8s., agreeing nearly with Sir William Herschel's 10h. 16m. 0·4s. from a quintuple belt seen in 1793, was derived which may be regarded as very near the truth. But apart from these and a few other observations it must be confessed that little is certainly known with reference to irregular markings on Saturn. Hall, with the 26-inch Washington refractor, Barnard, with the 36-inch Lick refractor and other telescopes, Young, with the 23-inch at Princeton, Hough, with the 18½-inch at Chicago, and others have all systematically endeavoured to distinguish spots on the planet's globe and all have failed, except in the particular case alluded to. The cream of observational talent, assisted by the finest and best telescopes ever constructed, has proved that irregular markings sufficiently well pronounced to be distinctly visible are somewhat of a rarity. Yet it should be stated that certain other observers discern alleged spots with ease and in prolific numbers as well as under many varieties of shape and tint. Indeed, the Saturnian spots would appear to be as frequent and to have as many vagaries as the markings on Jupiter if we may accept the testimony of a few observers. Whether these things are objective realities or the products of visionaries remains to be proved by the severe tests which future researches will apply.

Saturn comes to conjunction with Jupiter at intervals of about twenty years, previous conjunctions having occurred on April 22, 1881, October 25, 1861, January 26, 1842, June 19, 1821, July 16, 1802, &c. The ensuing conjunction takes place on the morning of November 28 next at 6 h., when Jupiter will be 0° 27′ south of Saturn. In 1881 the planets were 1° 18′ apart, in 1861 0° 52′. Mr. Crommelin gives the results of some computations in the *Monthly Notices*, lxi. p. 118, which show that the distance of the centres of the two planets will be less than 1° between November 21 and December 5. The near approach of these attractive objects will form an event of considerable interest to the general public as well as to the astronomical world.

W. F. DENNING.

MARINE BIOLOGY IN LIVERPOOL.

THE Editor of NATURE invites me to write a short account of the marine biological investigations and the scientific fisheries work carried on of late years in the Liverpool district, and I have pleasure in complying with this request since it will enable me both (1) to acknowledge the services of friends and fellow-workers, and (2) to distinguish between three very different local bodies whose work is frequently—and perhaps not unnaturally—confounded even by marine biologists and even in Liverpool. These three bodies are the Liverpool Biological Society, the Liverpool Marine Biology Committee, and the Lancashire Sea-Fisheries Committee. They are perfectly distinct in organisation, control and object, and although the work they do is to some extent similar, still, as a result of friendly arrangement and cooperation, there has been absolutely no rivalry and no overlap or duplication of work such as might under other circumstances cause waste of time, funds and opportunity. Let me state briefly the position and work of each of these three bodies, all of which are now contributing actively to the elucidation of the marine biology of the Irish Sea.

I. *Liverpool Biological Society*.—This is a public scientific society in the town, like its well-known sister society, the Liverpool Geological Society. It meets monthly in the zoological department of University College, and all local lovers of nature are eligible for membership. The president this session is Prof. A. M. Paterson, and the hon. secretary Mr. J. A. Clubb, of the Free Public Museum. The past presidents include the professors of all the biological departments in University College (anatomy, physiology, botany and zoology), the head officials of the Public Museum and such well-known local biologists as the late Dr. Drysdale, Dr. Wiglesworth and Mr. Isaac Thompson. The Society is now publishing its fifteenth annual volume of *Proceedings and Transactions*. The *Proceedings* at the beginning of the volume contain a brief record of the proceedings at the meetings, including exhibits; while the *Transactions* consist of those papers which the council decides to print in full. Although the greater number of the papers in the published volumes deal with the marine animals and plants of the district, still biology in the widest sense is represented at the meetings and in the publications, and communications will be found on ornithology, entomology, palæontology, embryology, botany, anatomy, physiology and even archæology. It has been customary for the president in each session to invite some outside original worker in his own department of biology to come and address the Society. In this way important lectures have been given by Drs. Gaskell, Sorby and D. H. Scott, and by Profs. Howes, Haddon, Miall and others. The address this year will be given by Prof. D. J. Cunningham, on the lessons to be drawn from the condition of the skull and the brain in the microcephalic idiot.

II. *Liverpool Marine Biology Committee*.—This, in contradistinction to the Biological Society, is a private body. It is not a Committee of the Society or of anything else, but is an independent organisation. It was constituted at a meeting of biologists held at University College in March, 1885, for the purpose of carrying out a scheme of investigation of the local marine fauna and flora with the intention of publishing reports thereon. The dredging, trawling and other collecting expeditions organised by the Committee have been carried on intermittently since that time, and a considerable amount of material, both published and unpublished, has been accumulated. Fourteen annual reports of the Committee and five volumes dealing with the fauna and flora have been issued since 1886.

At an early stage of these investigations it became evident that a biological station or laboratory on the sea-shore, somewhere nearer the usual collecting grounds than Liverpool, would be a material assistance in the work. Consequently, the Committee in 1887 acquired a lease of Puffin Island, on the north coast of Anglesey, and established there the L.M.B.C. Puffin Island Station,[1] which formed the centre of their work at sea for five years. Later on, in 1892, finding that their work was extending, and that the very limited accommodation at Puffin Island was insufficient, they moved to the more commodious and more convenient biological station at Port Erin,[2] in the centre of the rich collecting grounds of the south end of the Isle of Man. This locality has proved so interesting and so perfectly suitable in every way that it is likely to remain as the permanent marine laboratory of the Liverpool naturalists; while the office of the Committee, the place of meetings, the publishing centre and the museum, is the zoological department of University College, Liverpool.

The Committee consists of twelve members who were chosen originally as being representative naturalists of Liverpool, Manchester, Southport, Chester and the Isle of Man—and most of these members are still active workers. Amongst our losses, by death, are Prof. Milnes Marshall, the Rev. H. H. Higgins and Mr. Francis Archer. The Committee subscribe amongst themselves and ask for contributions from their friends in Liverpool. In this way, aided by occasional grants from the British Association and other bodies, they have paid the expenses of numerous dredging expeditions, have maintained their small biological station, with a resident curator (now Mr. Herbert C. Chadwick), for fifteen years and have issued a considerable number of publications. The regular income for the last few years has averaged about 200*l*. per annum, but in addition several friends in Liverpool, amongst whom may be mentioned Mrs. George Holt and Mr. F. H. Gossage, have kindly placed sums in the hands of the present writer to be expended either in special expeditions or in the publication of memoirs requiring plates. Thus it will be seen that the funds at the disposal of the Committee, although, thanks to the generosity of friends and the economical management of our hon. treasurer, Mr. Thompson, they have sufficed up to the present, are evidently too small and too precarious to admit of much advance; and consequently an appeal will sooner or later have to be made for a permanent endowment of the Port Erin Biological Station.

The publications of the L.M.B.C. consist of:—(1) the annual report, issued primarily to subscribers and other friends in Liverpool. Although this report gives a brief account of the investigations undertaken during the year, still it is to be regarded, not mainly as a scientific, but rather as a business publication for the purpose of keeping the organisation together and in touch with the people of Liverpool. (2) The volumes of the "Fauna of Liverpool Bay," containing reprints of those papers communicated by members of the Committee, and others working at the laboratory, to the Liverpool Biological Society, and which deal with the local fauna and flora. These volumes are bound and issued at irregular intervals when sufficient material has accumulated.

[1] See NATURE, vol. xxxvi. p. 275. [2] See NATURE, vol. xlvi. p. 155.

Five volumes have now appeared, bearing the dates 1886, 89, 92, 95 and 1901. (3) The "L.M.B.C. Memoirs," a series of detailed descriptions of the structure of certain common typical animals and plants, chosen as representatives of their groups and dealt with by specialists. Memoirs on the following types have already appeared or are in the press: I. *Ascidia*, II. *Cardium*, III. *Echinus*, IV. *Codium*, V. *Alcyonium*, VI. *Lepeophtheirus* and *Lernaea*, and VII. *Lineus*. Several others are nearly ready, and about thirty-five in all have been arranged for. Amongst other L M.B.C workers whose names have not been mentioned are Mr. A. O. Walker, Mr. Arnold Watson, Mr. A. Leicester and Prof. Harvey Gibson.

III. *Lancashire Sea-Fisheries Committee*.—The district controlled by this Committee (recently amalgamated with the former Western Sea-Fisheries District to form what is now officially styled "The Lancashire and Western Sea-Fisheries District") is probably the largest, and in several respects the most important, of the sea-fisheries districts which have been established since 1890, in connection with the County Councils, round the coasts of England and Wales, under the Sea-Fisheries Regulation Act of 1888. The district extends from the Duddon, in Cumberland, to Cardigan, in South Wales, and thus runs for about 441 statute miles along the shores of the Irish Sea. It bounds in all nine counties and contains about 1500 square miles of sea. Nearly every kind of English sea-fishing is carried on within this district, including fish-trawling, line-fishing in all its branches, drift net, trammel net and draw net fishing; set nets and stake nets, weirs and hedge-baulks are also used. Besides these there is a very large shrimping industry which is carried on by the use of shrimp trawls, shank nets, hose nets and push nets. Lobsters, crabs and prawns are taken in many places, and there is a very large area of shell-fish beds—mussels, cockles and oysters.

The work of the Committee is mainly administrative, and is carried out by a superintendent, Mr. R. A. Dawson, who has at his command an efficient steamer and a staff of bailiffs. There is also a scientific department, of which the present writer is hon. director, and the work of which centres in Liverpool. In that department we have a central fisheries laboratory in University College, and a branch laboratory with sea-fish hatchery at Piel, near Barrow in the north of Lancashire. The fisheries assistant at Liverpool is Mr. James Johnstone, and the resident assistant in charge of the Piel Hatchery is Mr. Andrew Scott. Both these gentlemen are known to marine biologists by their investigations, those of Mr. Johnstone being on the mussel and the cockle, and those of Mr. Scott for the most part on Copepoda and fish-hatching.

The work of the scientific department of the Lancashire Sea-Fisheries is most varied throughout the year, and ranges from teaching fishermen and keeping up a fisheries museum to hatching fish, reporting on oysters, and carrying on research in regard to all kinds of fisheries problems. The following headings of sections in the last published annual report (the ninth) will give an idea of the scope of the work: required survey of fishing grounds, fish-hatching, spawning of mussel, statistics of shrimping grounds and fish, relation of deposits to shrimps, sporozoon parasite of the plaice, Copepod fish parasites, circulating fisheries exhibition, laboratory classes for fishermen, inspection of shell-fish beds, and the question of sewage contamination. In this report it is urged that "what we stand most in need of at present is full and accurate statistics in regard to our fisheries, and much more detailed information than we have as to the distribution round the coast both of fishes in all stages of growth and also of the lower animals with which they are associated and upon which they feed". . . "We must, in fact, get series of accurate observations which will give us fair samples of the more sedentary populations of our seas on the different grounds, such as trawling grounds, shrimping grounds, nurseries and spawning banks at the different seasons". . . "My contention, then, is that such an investigation of our seas must be made, that it is urgent and should be made now, and that the Irish Sea is favourably situated and circumstanced at present to be made a test case before undertaking the much wider and still more difficult expanse of the North Sea, complicated by international questions. The Irish Sea is of moderate and manageable dimensions. It is all bounded by British territory and by sea-fisheries authorities which might agree as to their regulations. It is a 'self-contained' fish area, containing both shallow and deep water, spawning banks, feeding grounds and nurseries. It has several laboratories (Liverpool, Dublin, Port Erin and Piel) on its borders which would form centres for investigation, and it is controlled by powerful sea-fisheries authorities, two of which at least (Lancashire and Ireland) are provided with excellent steamers which might combine in the work. All that is required, beyond a carefully considered scheme, is authority from Government to the local committees to carry out such work, and a subsidy for, say, five years, to meet the increased expense." It is pointed out that there are two methods by which the required survey of our seas might be effected:—(1) By forming a properly equipped Government department (in some respects like the Geological Survey), with laboratories and steamers and a scientific staff competent to tackle the scientific problems involved; and (2) by making use of existing organisations, giving fuller powers to the local committees, and by encouraging and enabling them to spend money on the necessary investigations in their own districts.

It has been found in Liverpool that the only effective way of teaching fishermen is by means of practical classes. Lectures of all kinds, followed by discussions long and short, demonstrations microscopic and otherwise, have been tried in vain, or with only qualified success. Of course the brighter spirits amongst them, the picked men, can be instructed by any method, but for the average fisherman it takes the patient hammering of hour after hour and day after day in a laboratory class, where you appeal, not only to his ears, but also to his eyes and his fingers, and where he makes and remakes his own preparations, cleans his own cover-glasses and focusses the microscope for himself, before he can understand and will believe what he is told and sees, and finally becomes convinced, for example, that he is really looking at a young fish inside a minute transparent egg caught on the surface of the sea, or that what he and his fellows have always stoutly maintained to be the spawn of flat fishes is after all only the egg-capsule of an Annelid.

After deciding that this was the best plan to adopt in applying technical instruction to the fisheries, we started these laboratory courses in Liverpool last spring (February 1900). Two courses were held last year, two are being held this spring, and two others will follow later in the summer. The Technical Instruction Committee defrayed the expenses of the fishermen. That is, they gave 5*l*. to each man to meet his travelling expenses and his board and lodging in Liverpool during the fortnight he was under instruction. No charge was made for instruction or for the use of the microscopes, dissecting instruments, material and reagents—everything necessary was supplied by the laboratory. The teaching was carried on by Mr. Johnstone under my supervision, and the whole course was entirely practical in character, each man examining everything for himself and working every day, both forenoon and afternoon. For details as to the work of the course I must refer to our report, but I may say, in conclusion, that the results were most encouraging, and that from the reports of the superintendent of fisheries to his committee there can be no doubt as to the success of the method in the eyes of the fishermen and of the sea-fisheries officers.

I must now have nearly reached the limits which the Editor asked me not to exceed, and so I fear I must not enter upon further details, although I should have liked to have told how Mr. Thompson and Mr. Scott are working at the Copepoda, Mr. Chadwick and Mr. Ascroft at plankton, Mr. Johnstone and Dr. Jenkins at fishery statistics, Mr. Cole at the nerves of the flat fishes, and others of my excellent assistants and colleagues at various other special problems. But I must be content for the present with the above sketch of the local marine biological and fisheries work which centres in Liverpool, and with the following expression of my strong convictions on two points. I feel certain—

(1) That for such work the great thing is friendly co-operation. The field is so enormous and the work so varied in its nature that there is room and use for many individuals of very different capabilities. And if the work is to be carried on without Government subsidy or large endowments it is necessary to attract and combine various local organisations, such as University, County Council, local scientific societies, and that characteristically English product the serious amateur who does excellent original scientific work.

(2) That this work is only beginning, and that a great future lies before marine biology in all its branches, including the application of scientific methods to the investigation of fisheries problems.

W. A. HERDMAN.

PUBLIC HEALTH IN AMERICA.

THE thirty-first annual report of the State Board of Health of Massachusetts, dealing with the work of the various departments during the year 1899, has lately been issued. These reports are mainly known to this country in connection with the original investigations on the treatment of water and sewage which have for many years past formed an important feature of the work undertaken by this Board of Health.

The practical outcome of these researches is seen in the recommendations made by the Board to cities and towns, no less than 79 applications for advice regarding the establishment of systems of water supply, drainage and sewerage having been dealt with during the year, and the Board have the satisfaction of reporting that at the end of this period every city in the State and 132 out of a total of 321 towns were provided with public water supplies. If the death-rate from typhoid fever over a series of years be taken as an index of the sanitary condition of a community, then, indeed, the State of Massachusetts has just cause for congratulation on the results of the enlightened policy in regard to questions of hygiene which has been so persistently pursued by, and has so prominently distinguished, its officials.

In the years 1871–75 the death-rate from typhoid fever in the cities, as well as in the State at large, was as high as 8·2 per 10,000. This figure has gradually been reduced to 2·6, and in the four years from 1896 to 1899 the rate has been further brought down to 2·4 per 10,000. Again, while in the period 1871–75 there was not a single city amongst the 31 in the State having a lower death-rate from typhoid fever than 2·7 per 10,000, in 1899 there were 24 such cities. The most noteworthy improvement was that of Lawrence, where the typhoid death-rate fell from a mean of 11·2 per 10,000 in 1886–90, and 7·7 in 1891–95, to 2·5 in the four years 1896–99, following the introduction of sand filtration of the water from the Merrimack river supplied to this city.

In regard to consumption, the Board is able to make a no less satisfactory report, the decline in mortality from this disease having continued with a fairly steady and uniform rate throughout the past fifty years, reaching in 1899 18·7 per 10,000. In commenting upon this fact it is pointed out that it is between the ages of 15 and 60 that consumption is most fatal, and that in 1894 and 1895, out of 1000 deaths from all causes in Massachusetts between these ages 288 were due to tuberculosis, whilst in Paris the figures for the same period of life were 400 and in Vienna 459, or nearly one-half of all the deaths at that age. Emphasis is laid upon the necessity for taking further precautions for the control and prevention of this most destructive disease, a sentiment which will be given practical effect to this year in England at the British Congress for the Prevention of Consumption, presided over by the King, to be held in London in July.

Massachusetts is, however, not the only State in America which is alive to the urgency of dealing effectively with this disease. Michigan, which supports a State Agricultural College, has recently issued a valuable *Bulletin* in which practical methods are suggested for combating this scourge, based upon careful scientific experiments. The writer of the *Bulletin* states that tuberculosis causes more than twice as many deaths in Michigan as any other single contagious disease, and Dr. Keen, of Rhode Island, has calculated that more than 100,000 persons annually die of consumption in America, and that at this rate out of the 70,000,000 people in the United States 10,000,000 are practically condemned to death through tuberculosis.

In discussing the unusual prevalence of small pox which has characterised the period covered by the report, a special table has been appended showing the comparative fatality of the vaccinated and unvaccinated respectively. This table is based upon carefully compiled statistics kept between the years 1885 and 1899, and shows that the deaths from small pox among the vaccinated was 7·6 per cent. and among the unvaccinated 26·0 per cent., or more than three times as great in the latter case during these fourteen years.

In the pathological department of the Board much attention has been bestowed upon the preparation of diphtheria antitoxin, and a large number of examinations were made for the verification of diphtheria germs. The work of this department has largely increased during the year, for considerable quantities of the antitoxin have been used for the immunisation of healthy persons who have been exposed to the infection of diphtheria, whilst at the Children's Hospital, an institution at which several hundred patients are annually received for treatment, medical and surgical, but not for infectious diseases, it has been the custom to immunise each patient with diphtheria antitoxin soon after admittance.

No reference is made to the preparation of antityphoid serum, neither, apparently, have any investigations been carried out with regard to it. Likewise we note that tetanus antitoxin is no longer prepared, the reason given for its discontinuance being that the demand for the serum was small and irregular, and its application usually delayed until the patient was past recovery.

An interesting section of the report deals with the results of the food and drug inspections. Although the use of preservatives or any foreign substance in milk is illegal, 11·6 per cent. of the samples examined contained a preservative, in the largest number of cases formaldehyde being employed, which is widely used in the United States under the name of "Freezine." A pamphlet setting forth the special advantages of this preservative states that "it is not an adulterant, that it immediately evaporates, so that it defies detection as soon as it has rendered all the bacteria inert, it is beneficial to the health of infants, many of whom have been saved from sickness and even death by a liberal use of 'Freezine' in the milk!"

Butter, we are informed, was specially tested for the presence of boracic acid in consequence of the alleged extensive use of this ingredient in Great Britain. None was found, which may be attributed to the custom which prevails to a much larger extent in America than in England of eating salt butter, in which case the use of an additional preservative would be superfluous.

The above brief sketch may give some idea of the general scope of the work undertaken by public boards of health in America. It serves to emphasise, perhaps, that Great Britain is still waiting for an Imperial Board of Health, and that what individual States in America can accomplish we as an Empire are powerless to achieve.

G. C. FRANKLAND.

THE EXTENSION OF KNOWLEDGE.

AN inspiring address, dealing with the influence of universities upon national life, delivered at the Johns Hopkins University at the last commemoration day by Dr. D. J. Hill, assistant secretary of State, is published in one of the University Circulars just received. Students of human history well know that the pursuit of knowledge has been the fundamental factor of progress through many centuries. The earliest universities in Europe were associations of teachers and students with this aim, and they exerted a powerful influence upon society long before their existence was recognised by Church or State. "It is not too much to say," remarks Dr. Hill, "that the transformation of Europe which marks the distinction between mediæval and modern times has been chiefly the work of the universities, for they have exercised the most potent influence upon social progress and popular liberty of any single class of human institutions." The spirit which has led to the establishment of so many institutions for higher education in the United States, by private munificence, seems to have been inherited from the Pilgrim Fathers. Even when the colony of Massachusetts numbered only four thousand, it was decided to found a college; but the resolution is less astonishing when it is remembered that among the first six hundred settlers one in every thirty was a graduate of Cambridge.

Dr. Hill concluded his address by referring to the changing conditions of life, and the need for all who are concerned with education to recognise their new obligations and make themselves equal to their modern mission. This part of the address is reprinted below.

"It is no longer a question of merely popular education, although that is always fundamental; it is a question of the higher and the highest education that confronts us now. We have passed the primary stage, the common schools are established, the colleges exist in sufficient numbers, and even universities do not need to be multiplied. We have sought the safeguard of liberty in the universal diffusion of knowledge, but it is not the mere rudiments that have saved us in any great emergency. In what crisis of diplomacy, in what complicated question of finance, in what quandary of economic policy, in what problem of constitutional interpretation have the elementary arts furnished saving knowledge to the nation? No, in every grave complication, it is not these mere elements that are needed—though they indeed are always indispensable—but some broader and superior knowledge, some finer detail of information, some more acute discrimination, some keener analysis of evidence, some more penetrating intellectual vision or more ripened judgment—the fruits of long and serious study, which a whole nation of half-trained persons could not supply; and in the moment of perplexity it is to some quiet scholar or studious thinker that the nation makes appeal; and when he speaks light dawns, the clouds are swept away, and the path of action is made plain. . . .

"The time has gone by when merely individual and local efforts can secure to our country its place among the nations; for we have entered upon a period of world-relations—of world competition, of world policies and of world beneficence—from which it is impossible to recede. Our only hope of great national prosperity lies in the possession of a world-culture that will place us on a level with the best thought and highest knowledge attainable by man. Every humblest toiler on the farm and in the factory will henceforth be affected by the discoveries of science, the movements of foreign commerce and the resources of national industry. We have won our present industrial pre-eminence, without the advantages of technical education, through the fertility of our soil and a native genius for construction and organisation; but the time must come, and it may not be far distant, when the highest technical education will be necessary to the success of the simplest American industry. The competition of the hand is rapidly resolving itself into the competition of the brain, and the comprehension, guidance and application of natural forces in accordance with natural laws become questions of national consequence.

"Give us, then, O learned doctors, more discoveries of science, for we know not what new revelations may yet burst forth from your laboratories; give us more of art, for it is only through the channels of expression by word and sign and symbol that new truth can be lodged in the minds of the people; give us more of history, for it is only by conning the lessons of experience that the children of men grow wiser; give us more of literature, for it is only through the life of letters that man rises to the full comprehension of himself; give us more of ethics and philosophy, for it is only in the light of great principles that character becomes firm and conduct noble; let earth, and sea, and sky, and the stars in their courses, the long struggle of man and the story of his aspirations, the tongues of the busy day and the silence of the voiceless night, the instincts that stir us to passion and the still small voice that drops its calm out of eternity, all teach us the ways of creation and the mystery of our divine descent; for it is through the totality of their culture that nations rise, and through ignorance or defiance of unbending laws that nations fall."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Dr. G. C. Bourne has been appointed to represent the University on the Board of Governors of Coopers Hill College.

The seventh Robert Boyle lecture will be delivered by Prof. Sylvanus Thompson on June 6; the subject will be "Magnetism in Growth."

Mr. H. B. Hartley, scholar of Balliol College, has been elected to a fellowship at that college as science tutor in succession to the late Sir John Conroy. Mr. Hartley obtained a first class in chemistry and mineralogy in 1900.

CAMBRIDGE.—Sir W. Martin Conway has been elected Slade professor of fine art in succession to Dr. Waldstein.

Seventy-three men and twenty-six women have acquitted themselves so as to deserve mathematical honours in the first part of the tripos.

It is proposed to appropriate from the Benefaction Fund a sum of 21,000*l.* to the new botany school building, and 16,000*l.*, together with some 5500*l.* specially contributed, to the new medical school building.

Prof. Macalister is appointed an examiner in anatomy for medical degrees in the place of Dr. Barclay-Smith.

THE field studies in natural history arranged by Mr. David Houston for the Essex Technical Instruction Committee provide an excellent means of becoming familiar with nature, and should be of special assistance to teachers who desire to adopt the scheme of nature study recently issued for rural schools by the Board of Education. Rambles are arranged for Saturday afternoons, and demonstrations in general natural history are given by the director, so that an introductory knowledge of the natural vegetation of the county can be obtained in a pleasant way. A ten days' vacation course has been arranged to be held in the New Forest, from August 12 to 22. The programme of the course, and the field notes appended to it, show that the members of the party will have the opportunity of spending a profitable short holiday in the New Forest and neighbourhood.

APPROVAL of the Government Education Bill has been expressed by several educational bodies concerned with technical and secondary education. The chief difficulties raised by the Bill relate to the constitution of the local authorities to be responsible for the educational work of their respective districts, and the funds which are to be available for technical and secondary education. At present technical instruction committees administer the "whisky money," and in a few places an additional penny rate is also levied. The new Bill proposes to let the local authority administer these funds, and to give it the power to levy another penny rate; but as the funds are to be used for both secondary and technical education, the extension of rating power is wholly inadequate to the requirements. This view is held by the council of the Association of Technical Institutions, and in order to give expression to it a special meeting of the Association will shortly be held. Resolutions will be brought forward to the effect that, while the general principles of the Bill are approved, adequate provision must be made to defray the necessary additional charges in respect of secondary education which will fall upon the local authorities, and technical instruction must be provided for before the residue available under the Local Taxation (Customs and Excise) Act is used for purposes of secondary education in general.

SCIENTIFIC SERIALS.

Annalen der Physik, May.—Researches on the normal cell, especially the Weston element, by W. Jaeger and St. Lindeck. This paper contains the results of an exhaustive experimental study of the Clark and Weston cells. The researches of E. Cohen had thrown some doubts upon the suitability of the Weston cell as a standard, especially in the neighbourhood of 0° C. In the present paper it is shown that these irregularities only occur about 0° C. and with the cell containing 14·3 per cent. amalgam, no trace of any irregular deviations appearing when the cell is used at 10° C. or higher temperatures. Further, if the amalgam is made slightly weaker in cadmium, 12 per cent. or 13 per cent., these irregularities near 0° disappear, and the measurements are trustworthy at all temperatures. It is concluded that the strictures of Cohen with regard to this cell are not justified, and that the Weston element is eminently suitable as a standard of electromotive force.—The calculation of isotherms, by C. Dieterici. The fundamental equation of condition of van der Waals is modified, in part empirically, without assuming that the cohesion pressure and the volume correction are determined, and the results applied to the measurements of Young on isopentane and benzene, of Ramsay and Young on ether and water, and of Cailletet and Matthias on sulphur dioxide and carbonic acid.—Contribution to the theory of electric discharges in gases, by J. Stark.—On the variation of the dielectric constant with pressure and temperature, by J. Koenigsberger.—The constancy of the sparking potential, by K. R. Johnson.—On Jaumann's clear J-surface, by A. Korn. A discussion of a phenomenon first observed by Jaumann in a vacuum tube.—The internal friction of argon and its variation with temperature, by H. Schultze. The absolute value found for the viscosity coefficient of argon is practically identical with that previously determined by Lord Rayleigh, but the alteration of viscosity with temperature is found to be somewhat greater according to the author's experiments. The formula suggested by Sutherland gives a good approximation to the results of the experiments.—On the internal friction of gases and its change with the temperature, by P. Breitenbach. An application of Sutherland's formula to the experiments previously published by the author on the temperature coefficient of the viscosity of air, ethylene, carbonic acid, hydrogen and methyl chloride. The agreement between the calculated and experimental results is so good as to amount to a proof of Sutherland's theory.—The equilibrium figures of powders, by F. Auerbach.—On the influence of temperature on the elasticity of metals, by C. Schaefer. Experiments were carried out on nine metals, and the value of the torsion modulus measured at – 186° C., – 70° C. and about 20° C. If the temperature coefficients of the different metals are plotted as ordinates, and the melting points as abscissæ, a smooth curve passes through the whole of the results.—Remarks on a paper of T. Middel on the cause of the thermal change of delicacy in balances, by W. Felgentraeger.—Liquid crystals, by O. Lehmann. A reply to some remarks of G. Tammann.—On the distribution of electricity on an ellipsoid, by G. Jaeger.

Symons's Meteorological Magazine for May contains a useful reference table of the annual means and extremes of the meteorological observations taken at Camden Square for each of the forty years 1858–97. During the years 1898 and 1899 Mr. Symons gave for each month the means and extremes for the various elements, and the present third set of tables completes this unique and valuable record of the climate of London. It may not be out of place to quote a few of the extreme values of the period in question, which are shown by a glance at the table, although we have referred to most of them on former occasions. The highest solar radiation temperature (since 1870) was 137°·7 in 1881, and the lowest terrestrial radiation temperatures (since 1860) were 0°·6 in the same year and 0°·5 in 1867. The extremes in the screen were 94°·6 in 1881 and 6°·7 in 1867. The same low reading occurred in 1860, and 7°·3 in the severe frost of 1895. The greatest rainfall (34·08 inches) occurred in 1878, and the least (16·93 inches) in 1864.

SOCIETIES AND ACADEMIES.

LONDON

Anthropological Institute, May 14.—Mr. R. Shelford, of Sarawak, exhibited a number of carved bamboos and commented on the elements of Dyak decorative art.—Mr. W. MacDougall read a paper by Dr. Hose and himself on the animal cults of Sarawak. He showed that though many of them exhibit elements frequently associated with totemism, such as the respect paid to an animal believed to be the resting-place of the soul of a deceased ancestor, totemism itself could not be regarded as the starting-point of any of the cults, and was at most only present in a rudimentary stage. He also gave details as to the beliefs of the Sea Dyaks about the Nyarong or spirit-helper believed to be acquired by some men in dreams.

EDINBURGH.

Royal Society, May 8.—Dr. Burgess in the chair.—Prof. Copeland and Dr. J. Halm, in further notes on the new star in Perseus, gave a description of the changes which had accompanied the star's decrease in brightness. One of the most interesting features was the periodicity which had recently established itself, indicating a period of three to five days with a possible longer period of several weeks. The corresponding changes in the spectrum were also discussed, the apparent shifting of certain bands being explained as due to the fading of the one and the relative brightening of the other of two overlapping bands. Broadly speaking, the change in the spectrum had been towards the nebular type. It was suggested that the absorption bands flanking the bright bands were an effect of high internal pressure.—Prof. John Gibson read a paper on certain relations between the electrical conductivity and the chemical character of solutions, following up a previous communication published three years ago. The paper was based upon a large number of experiments, some of which had been going on for years and were not yet completed. The broad principle underlying the results he had obtained was that in solutions inter-molecular reactions tend towards maximum specific electrical conductivity. In one series of experiments solutions of hydrochloric acid of varying concentration were formed and a small proportionate quantity of chromic anhydride added to each. In strong solutions above the concentration which gives the maximum specific conductivity, the reaction, represented by the equation $12HCl + 2CrO_3 = 2CrCl_3 + 6H_2O + 3Cl_2$ and indicated to the eye by the change in colour, went on more rapidly the further removed the concentration was from that which corresponds to the maximum specific conductivity. In one experiment the critical concentration of 18·2 per cent. was used and the mixture kept in the dark. The reaction is not yet complete, although three years have elapsed. With a 20 per cent. solution the reaction was completed in about six months, and with a 24 per cent. solution in less than one month. Similar results were obtained with other solutions involving more rapid reactions, requiring for their completion times comprised within a small number of weeks or even minutes. In the case of sugar solutions another determining factor came in, namely, the viscosity, a diminution in which by the destruction of the sugar by sulphuric acid increases the conductivity independently of change in concentration. An interesting illustration of the same principle was afforded by the fact that in vinous fermentation a greater concentration than about 14 per cent. cannot be obtained. By making a series of artificial musts with proper proportions of salts, sugar and alcohol so as to represent approximately successive stages of the fermentation, Dr. Gibson found that the conductivity approached a maximum as the concentration of alcohol approached 14 per cent. The paper ended with a novel and interesting discussion of the phenomena of plant life along the same broad physico-chemical lines. The *rôle* of the inorganic salts necessarily present in the sap, the special usefulness of certain salts and the influence of varying concentration were discussed and connected with principles in regard to photochemical action and chemical action generally embodied in two short papers read in 1897 and published in the Society's *Proceedings*.—Prof. George Forbes, F.R.S., read an additional note on the Ultra-Neptunian planet the existence of which is indicated by its action on comets, supplementing papers on the same subject published twenty years ago. The general idea was that comets were attracted into the solar system by the action of outlying planets; and there were seven comets having aphelion positions corresponding with positions of a planet revolving round the sun at a distance 100 times that of the earth, with a period of about 1000 years. It was suggested that this planet, by its disturbing action on the comet of 1264 and 1556, which had not reappeared as expected in 1848, had so altered the elements of the orbit as to make it no longer recognisable; and reasons were given in favour of the identification of the lost comet with either the comet 1844 (3) or the comet 1843 (2), both of which had parabolic orbits assigned. If these were assumed to be ellipses of the proper size the aphelion positions would not be far removed from the positions occupied by the supposed planet. To produce the changes demanded in the orbit the mass of the supposed planet would, however, require to be greater than that of Jupiter.

PARIS.

Academy of Sciences, May 20.—M. Fouqué in the chair.—On the total eclipse of May 18, by M. J. Janssen. A short report on observations of the recent eclipse by M. de la Baume, at Sumatra. The rotation of the sun's corona, and the presence of Fraunhofer's lines in the light thereof, have not been confirmed.—Researches on the condition of alumina in soils, by M. T. Schlœsing. A number of specimens of earth from Madagascar were found to contain considerable quantities of alumina, either in the free state or in the form of a silicate readily attacked by dilute caustic soda solution. The greater part of the alumina or the silicate exists in a pulverulent, sandy state, and is not the cause of the tenacity of the soil; it has no adverse influence on vegetation.—M. Laveran was elected to fill the vacancy in the Section of Medicine and Surgery caused by the decease of M. Potain.—On the eclipse of Jupiter's fourth satellite, observed at Paris, May 17, 1901, by M. G. Bigourdan.—Observations of the brightness of Nova Persei, by M. Luizet. The variations in the brightness of this star are said to show no regular periodicity.—On regular groups of a finite order, by M. Léon Autonne.—On the molecular depressions of the temperature of maximum density of water produced by the dissolution of the chlorides, bromides and iodides of potassium, sodium, rubidium, lithium and ammonium; the relations between these depressions, by M. L. C. de Coppet. The experimental results are given in tabular form. The lowering of the temperature of maximum density is proportional to the quantity of salt dissolved, whilst the *molecular* lowering is almost constant. Lithium salts, however, are an exception to the latter rule, their molecular lowering increasing with the concentration. The salts of sodium are the most, and those of lithium the least, active. Iodides produce a greater depression than bromides, and bromides than chlorides, the relations between the observed values being the same for all the metals of the group.—Alcohols and calcium carbide, by M. Pierre Lefebvre. A continuation of previous work on the subject. In the present paper are given the results of the analysis of the gases produced by the action of the vapours of amyl, isobutyl, ethyl or methyl alcohols on heated calcium carbide.—On the condensation of acetylenic hydrocarbons with formaldehyde; synthesis of primary acetylenic alcohols, by MM. C. Moureu and H. Desmots. The action of the sodium derivatives of œnanthylidene or phenylacetylene on the solid polymeride of formaldehyde results in the formation of two new alcohols. Amylpropiolic alcohol boils at 98° under 13 mm. pressure, and has a specific gravity 0·8983 at 0°, whilst phenylpropiolic alcohol boils at 139° under 16 mm. pressure, and has a specific gravity 1·0811 at 0°; both are colourless, oily liquids.—Action of acid chlorides on ethers in presence of zinc, by M. P. Freundler. Remarks on a recent paper by M. Descudé.—Oxidation of primary alcohols by contact action, by M. J. A. Trillat. All primary aliphatic alcohols are oxidised when a mixture of air with the vapour of the alcohol is passed over a heated platinum spiral, and it is possible to limit the reaction to the formation of the corresponding aldehydes; the presence of water vapour appears to favour the oxidation. The use of porous substances, such as platinum black, tends to the production of acids rather than aldehydes. Acetals are also produced, at any rate from the lower alcohols; their formation is a reversible reaction.—On the substitution of zinc-white for white-lead in oil painting, by M. A. Livache. According to the author's experiments, the injurious white-lead in oil paints may be successfully replaced by zinc-white, provided certain conditions are observed.—The evolutionary cycle of *Orthonectides*, by MM. Maurice Caullery and Félix Mesnil.—On a glucoside characteristic of the germinating period of the beech, by M. P. Tailleur. The beech, in its germinating stage, contains a glucoside and a corresponding ferment which, in the presence of water, give rise to methyl salicylate and glucose, the latter being assimilated by the plant. The reaction is localised in the hypocotyledonous axis, and does not occur in the seed or in the old plant.—On the petrographic classification of the schists of Casanna and the Alps of Valais, by M. L. Duparc. A description of seven types of schist.—On the electrolysis of animal tissues, by MM. Bordier and Gilet. The fall in strength observed on the reversal of a current passed through animal tissues, is not observed to any appreciable extent if the tissues at the level of the electrodes are impregnated with an electrolyte.—On the formation of urea by the oxidation of albumin by means of ammonium persulphate, by M. L. Hugounenq. Under favourable conditions, about 5 per cent. of urea may be obtained by the oxidation of egg albumen by ammonium persulphate in alkaline solution.—New seismological observations at Grenoble, by M. W. Kilian.

DIARY OF SOCIETIES.

THURSDAY, May 30

Royal Institution, at 3.—The Chemistry of Carbon: Prof. J. Dewar, F.R.S.

Institution of Electrical Engineers (Society of Arts), at 8.—Annual General Meeting.

FRIDAY, May 31.

Royal Institution, at 9.—With the Allies in China: A. H. Savage Landor.

Physical Society, at 5.—On a Model which imitates the Behaviour of Dielectrics: Prof. Fleming, F.R.S., and A. W. Ashton.—(1) On the Resistance of Dielectrics and the Effect of an Alternating Electromotive Force on the Insulating Properties of India-rubber; (2) Note on the Electrification of Dielectrics by Mechanical Means: A. W. Ashton.

SATURDAY, June 1.

Royal Institution, at 3.—The Biological Characters of Epiphytic Plants: Prof. J. B. Farmer, F.R.S.

MONDAY, June 3.

Society of Chemical Industry, at 8.—The Need of Greater Care in Introducing Gas-Firing into Small Gasworks: G. Cecil Jones.—The Chemical Aspects of Bacteriology: Dr. Walter C. C. Pakes.

Institute of Actuaries, at 5.—Annual Meeting.

TUESDAY, June 4.

Zoological Society, at 8.30.—On the Structure and Affinities of the Anomodont Genus Udenodon: Dr. R. Broom.—Notes on the Type Specimen of *Rhinoceros lasiotis*, Sclater; with Remarks on the Generic Position of the Living Species of Rhinoceros: Oldfield Thomas, F.R.S.—On a Small Collection of Fishes from the Victoria Nyanza, made by order of Sir H. H. Johnston, K.C.B.: G. A. Boulenger, F.R.S.

WEDNESDAY, June 5.

Geological Society, at 8.—On the Passage of a Seam of Coal into a Seam of Dolomite: A. Strahan.

Entomological Society, at 8.—Cases of Protective Resemblance, Mimicry, &c., in British Coleoptera: Horace St. J. Donisthorpe.—A Revision of the American Notodontidæ: W. Schaus.

THURSDAY, June 6.

Royal Society, at 4.—Election of Fellows.——At 4.30.—*Probable papers*: On the Electric Response of Inorganic Substances, Preliminary Notice: Prof. J. C. Bose.—On Skin-Currents: Dr. A. D. Waller, F.R.S.—Vibrations of Rifle Barrels: A. Mallock.—The Measurement of Magnetic Hysteresis: G. F. C. Searle and T. G. Bedford.—A Conjugating Yeast: B. T. P. Barker.——Papers to be read *in title only*: Thermal Adjustment and Respiratory Exchange in Monotremes and Marsupials: a Study in the Development of Homo-thermism: Dr. C. J. Martin.—On the Elastic Equilibrium of Circular Cylinders under Certain Practical Systems of Load: L. N. G. Filon.—The Measurement of Ionic Velocities in Aqueous Solution, and the Existence of Complex Ions: B. D. Steele.

Royal Institution, at 3.—The Chemistry of Carbon: Prof. J. Dewar, F.R.S.

Linnean Society, at 8.—On the Necessity for a Provisional Nomenclature for those Forms of Life which cannot be at once arranged in a Natural System (Adjourned Discussion): H. M. Bernard.

Chemical Society, at 8.—A Laboratory Method for the Preparation of Ethylene: G. S. Newth.—Oroxylin: W. A. H. Naylor and C. S. Dyer.—Some Relations between Physical Constants and Constitution in Benzenoid Amines, II.: P. Gordon and L. Limpach.—The Constitution of the Acids obtained from α-Dibromocamphor: A. Lapworth and W. H. Lenton.—The Decomposition of Chlorates. IV. The Supposed Mechanical Facilitation of the Decomposition of Potassium Chlorate: W. H. Sodeau.—Condensation of Phenols with Esters of the Acetylene Series. V. Homologues of Benzo-γ-Pyrone: S. Ruhemann.—On the Action of Sodium Methoxide and its Homologues on Benzophenone Chloride and Benzal Chloride: J. E. Mackenzie.—Preliminary Note on Hydrides of Boron: W. Ramsay and H. S. Hatfield.—Gum Tragacanth: C. O'Sullivan.

Röntgen Society, at 8.30.—X-Ray Diagnosis of Aneurism: Dr. Hugh Walsham.

FRIDAY, June 7.

Royal Institution, at 9.—Mimetic Insects: Prof. Raphael Meldola, F.R.S.

Geologists' Association, at 8.—The Geysers of the Yellowstone: John Parkinson.

SATURDAY, June 8.

Royal Institution, at 3.—The Biological Characters of Epiphytic Plants: Prof. J. B. Farmer, F.R.S.

CONTENTS.

THURSDAY, JUNE 6, 1901.

WATER-POWER.

An Outline of the Development and Application of the Energy of Flowing Water. By Joseph P. Frizell. Pp. vii + 563. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1901.)

WATER-POWER, as developed in waterfalls, has been brought prominently into notice in recent years as an important source of power, owing to the facilities afforded by electricity of transmitting it to a distance; so that a small portion of the Niagara Falls and numerous minor falls have been utilised for supplying power economically for electric lighting, traction, and other purposes, to places many miles distant from the falls. The author, however, of this volume desires to direct attention to the more widespread sources of water-power contained in streams and rivers, which can be utilised either by taking advantage of the natural fall by means of suitable works, or by storing up the flow in flood-time in reservoirs formed by constructing dams across the higher parts of river valleys; and the water thus collected can be converted directly into power by using the available fall below the dam, which, however, is reduced in proportion as the water-level of the reservoir is lowered, or it can be employed in supplementing the discharge of the river below the dam during its low stage, so that the flow when used for driving hydraulic motors may never fall below a definite volume. The author points out that whereas in recent times water-power has been to a great extent superseded by steam-power, owing to the cheapness of fuel and improvements in steam engines, timber has already become much less plentiful in the United States, and even coal will in time be exhausted; whilst the sources of water-power will always remain, and have already become more available by the adoption of electrical transmission, which in its turn has led to many notable developments and improvements in the utilisation of power. Undoubtedly vast sources of power produced by the sun's heat are continually running to waste in rivers and streams, as evidenced by the estimate quoted by the author, that the power derivable from the St. Lawrence and its tributaries is nearly equal to that obtainable from all the coal raised yearly in the United States. The difficulty consists in rendering this power economically available, for a high fall and a regular flow furnish the most efficient source of water-power; whereas the fall of rivers is, for the most part, moderate and spread over long distances, and their flow very variable, more especially in the upper part of their course, where the fall is the greatest. It is, therefore, quite natural that waterfalls have been resorted to as a source of water-power, and for transmission to a distance, especially where they occur at some distance from the source of a river, and consequently possess a more regular flow; whereas the utilisation of the more ordinary flow of rivers, except for local purposes, seems destined to have to wait till a considerable increase in the price of fuel and the absorption of the most advantageous sources of water-power render it necessary to turn to less economical supplies. Where a river has a rapid fall for a considerable distance, it may be quite practicable to develop largely its available water-power, by regulating its flow by the construction of a reservoir by means of a dam of moderate height across the upper part of its valley, so as to render its discharge always adequate to actuate turbines placed at suitable points along its course.

After an introductory chapter upon natural water-courses, including a computation of the *flowage*, or raising of the surface and modification of the slope of a stream by a dam put across it, the author treats of the various forms of dams constructed across rivers and streams, in ten chapters extending over 209 pages, embracing in his descriptions fixed weirs and some forms of movable weirs, as well as earthen and masonry reservoir dams, with their methods of construction and some notable failures. Such works, considered here as applicable to the development of water-power, constitute essential constructions for the improvement of rivers for navigation, and for forming storage reservoirs for the water-supply of towns, which have been often described in books and papers relating to these branches of hydraulic engineering; and the author only enters in the latter half of his book upon the consideration of hydraulic motors, and the modes of transmission of the power thus obtained, which more specially appertain to his subject. Three chapters are devoted to the methods of conveying the water to the motors, and the arrangements for the regulation of the supply and the power; whilst the various forms of water-wheels and of turbines are described in two consecutive chapters. Some instances are next given of the utilisation of natural water-powers in the United States; and it is pointed out that the plan formerly sometimes adopted of dividing a considerable fall into two or three parts, so as to command a large area of ground for the mills, is an expensive system in regard to the motors, and wasteful of the power, and that with modern methods of distribution it is expedient to make use of the entire head. The most important and special part of the book, however, is contained in the following five chapters, in which the various methods resorted to for the transmission of power are considered, and some interesting examples of notable power-houses are described. The forms of transmission dealt with are shafting and wire ropes, hydraulic transmission, transmission by compressed air, and electrical transmission. All these methods of transmission and distribution of power have their respective utility, but they differ considerably in the distance to which they can act with efficiency. Thus shafting is useful for transmitting power throughout a mill or manufactory; but beyond three or four hundred feet wire ropes are more economical, and can be employed with advantage up to about a mile. Hydraulic transmission is valuable in storing up power for intermittent working, as required at docks and large canal locks; but its efficiency for driving machines at a distance of about a mile is only 50 per cent. Air compressed by means of water-power has been transmitted considerable distances for boring the headings of long alpine tunnels, which it has also served to ventilate; and compressed air has been used for the transmission of power in a mine in the United States to a distance of three miles; but the changes of temperature produced in the compression and expansion of the air necessitate special arrangements to avoid considerable loss of efficiency. Electrical transmission, the most modern and most effective method of utilising power at a distance from the place where it is generated, has notably augmented the value of the water-power of falls; for it has enabled the power-house to be established at the source of the power, and the power developed to be distributed to manufactories situated in the most convenient localities, far removed from the generating station. Thus the Telluride Power Transmission Company, at Provo, in Utah, transmits 2000 h.p. by electricity a distance of 55 miles, at the high voltage of 40,000 volts; whilst the Southern California Power Company, possessing a head of water of 750 feet at Santa Ana Canyon near Redlands, develops 4000 h.p., and obtaining a current at 750 volts transforms it to 33,000 volts and transmits it 80 miles to Los Angeles. In the chapter on "The Power-House," the general arrangements of such establishments are explained, and the power-houses at Lachine Rapids, on the St. Lawrence, at Mechanicsville, on the Hudson 18 miles above Albany, and at Sault Sainte Marie, on the rapids between Lake Superior and Lake Huron, are described.

The book is illustrated by two hundred and thirty-two drawings, sections and diagrams, distributed throughout the text, and is furnished with an index; but it does not contain any tables of contents of the twenty-five chapters, beyond a short title at the head of each, or any list of the illustrations. The materials for the volume have been, to a large extent, collected from the most noteworthy records of engineering societies and pages of engineering journals, as well as from plans of works carried out; and the principles involved and the results aimed at have been presented in a condensed and readable form. The book should prove useful in directing attention to the enhanced value of water-power, especially in view of the very important assistance afforded it by electrical transmission.

AN ANGLO-AMERICAN WORK ON THE MARKET GARDEN.

The Principles of Vegetable Gardening. By L. H. Bailey. Pp. x+458. (London: Macmillan and Co. Ltd., 1901.) Price 4*s.* 6*d.* net.

THIS work is one of a "Rural Science Series," edited by an American author, but it is by no means the best. Its principal fault is that in covering too much ground it fails to treat with thoroughness the numerous subjects which are included in the seven chapters described in the table of contents. The most important of these subjects are "The Soil and its Treatment," "Glass" in relation to glass culture, "Seeds and Seedage," the last a word quite new to the industry in England, the meaning of which is not absolutely clear, and "The Management of the Vegetable Garden."

In market garden culture success depends upon approximate perfection in the soil, the seed and the management; for the realisation of profit a further qualification must be added—marketing. Nor does the arrangement of the chapter simplify matters; a number of quotations from other authors, printed in small type, are introduced in order to show the reader what soil to select, but while these authorities do not absolutely agree, the majority select a deep sandy loam. Such a soil may be found under garden cultivation in Bedfordshire and in the potato growing districts of the Vale of York, but before a clay loam with a clay subsoil is condemned the reader should see farm gardening on the London clay and in the Lea Valley.

A large proportion of this important chapter is devoted to "Fertilisers," but stable manure, which is the foundation of early as of heavy crops, and of double and triple crops, is barely mentioned; indeed, excepting in a brief reference to the preparation of hot beds under glass, stable manure is absolutely unmentioned in the copious index. We remember, on visiting the extensive gardens attached to the great experiment station of New York State at Geneva, being informed how much the management owed to an English gardener. The editor of this work would have largely added to its value had he interviewed such a man, or an English market gardener of eminence.

The subject of "Seeds" is more fully treated, but in the whole 50 pages the details for which the practitioner will look are in large part conspicuously absent. The chapter is largely composed of useful figures drawn from the reports of experiment stations, but it has no very direct bearing upon the gardening industry. Nor can we speak more highly of the treatment of the next essential subject, "Management," which might be better arranged and which is abundantly fortified with quotations; there is, indeed, much that is useful, but if a grower seeks advice of a practical character he will not always find it. At the end of the chapter there are some recommendations which are intended to help the gardener to preserve his crops from the attacks of insects and fungi; but when we say that the most destructive of all soil insects, the wire worm, *Elater sp.*, is dismissed in half a dozen lines, we do not misrepresent the extent of the information. The gardener is wisely recommended to make Paris green into a paste, but in this country it is not sold in any other form.

The second part of the book, in which crops are discussed in greater detail, is much better arranged, although the author has adopted a form of classification which, if ingenious, has its difficulties. He groups the plants of the vegetable garden as roots, tubers, bulbs, salads, pulse, solanaceous crops and so on, but this arrangement is quite unscientific; the turnips and the beet, for example, classed as roots, are bulbs, while the potato, if a tuber, is also a member of the solanaceæ. Again, cabbages and the cauliflower are classed as cole crops, but both belong to the same family as the radish and rutabaga or swede turnip, both of which are classed as roots. Here we notice a curious error: "The rutabaga (is) known in England as Swedish turnip and turnip rooted cabbage, and in French as Chou navet." The French equivalent for swede, which is unknown in England as turnip rooted cabbage, is rutabaga. Let us add that although many of the illustrations are exceptionally good, that intended to represent the turnip is ludicrous as applied to the improved plant.

This part of the work is, however, by far the best, treating as it does of many plants peculiar to the United States, as well as of those common to the gardening of this country, but even here we find scrappiness and irregularity of treatment. To the cultivation of celery, for example, considerable space is devoted, and this is well utilised, whereas the pea is dismissed with a brief discussion, and the potato, of which so much more should be said, receives notice of quite an inadequate character. The author tells us that potatoes are planted in drills 3 to 3½ ft. apart, and that if pieces of tubers are cut to one eye, 8 to 10 bushels will be required to plant an acre; also that the yield averages about 75 bushels—or less than two tons to the acre. These statements, like many others, do not apply to British or to the best American practice. The farmer cropping in the poorer soil of the open field plants 28 to 30 inches apart; he employs 22 to 25 bushels of seed, seldom cutting it, and then only once, whereas a two ton crop would mean financial ruin. For facts relating to the size and selection of seed, the best size of cut sets, the method of box sprouting for early crops and the most economical methods of manuring, we look in vain.

We notice with pleasure from the quotations made that in the United States details are collected in relation to the area of land devoted to various market garden crops. The figures, and they relate to 1891, are in some cases remarkable; thus, asparagus covered 37,970 acres, whereas potatoes were grown on only 28,000. Similarly, the area devoted to seed production is shown in relation to 40 varieties. Again, 25 pages are devoted to a list of works by other authorities, with descriptive notes, and bulletins issued by the various experiment stations upon subjects connected with vegetable gardening. All this is useful to the American reader. One of the most practical remarks in the book is that in which the author says that if a man is only a plant grower and not a good business man he will probably be a slave to the salesman, but where the grower occupies a large area and possesses sufficient capital to work it he can dictate to the market.

We are sorry not to be able to give this work unqualified praise; it is admirably printed and illustrated, and will afford help to those who possess a knowledge of principles. We would conclude, however, with the remark that the principles which we recognise in England are identical with those which are taught in the United States, and we venture to believe that our practice and that followed in the Northern States have more in common than the practices of the farmers and gardeners of the north and south. The author does not fully comply with these requirements. It is true that a student may refer to a work of the same series on "Soil," but we think the author would have acted wisely had he devoted a short chapter to a description of soil, its varied character and composition, how it is improved by culture, and why it is adapted to particular crops. Similarly, a definition of the principles which underlie the practice of manuring might have found a place—and above all, for gardeners know a great deal more about the management of dung than of artificial fertilisers, the importance of chemical manures and the *rôle* they play might have been more fully recognised. Although, therefore, the book is written primarily for the American reader, there is no reason why it should not have been made as interesting and instructive to the great constituency on this side of the Atlantic.

LIBYANS AND EGYPTIANS.

Libyan Notes. By D. Randall-Maciver, M.A., and A. Wilkin, B.A. Pp. 113; 25 plates. (London: Macmillan and Co., Ltd., 1901.) Price 20*s.* net.

THE volume before us is, as the writers say, the result of an expedition to Algeria undertaken in the year 1900 with the view of obtaining such information as would lead to the solution of the vexed question of the early connection of the Berber tribes with Egypt. This handsome publication contains fifteen chapters, which are illustrated by a large number of beautifully executed plates, and deals in an exhaustive manner with subjects which appeal as much to the anthropologist in general as to the Egyptologist in particular. The writers begin their observations by references to the pictures of the Libyans which are found painted in Egyptian tombs, and from which we learn that this people had fair skins and beards and blue eyes; such pictures belong to the period of the XVIIIth and XIXth dynasties, but it does not follow that they represent, either physically or racially, the North African race or races which formed the indigenous substratum in the ancient Egyptian. Indeed, so long as M. J. de Morgan hesitates to apply the term Libyan to the predynastic Egyptians, less well informed mortals should hesitate before doing so.

The second chapter of the work gives a number of general observations on the Berbers, and we may remark in passing that the criticisms made by the writers on the Arabs show that they know little or nothing of the greatest branch of the Semitic race; nothing but youth and ignorance and prejudice can be pleaded in extenuation of them. We confess at the outset that we have no faith in the judgment, not to say scholarship, of writers who intrude personal opinions of the kind in a work which professes to be scientific. Chapter iii. deals with the political and social organisation of a Berber people, and chapters iv.-vi. with the Shawîya people and their manners, customs, &c.; the section on pottery is very interesting. Three chapters (vii.-ix.) are devoted to the description of the Kabâ'il, their country, houses, industries, &c., and this is followed by a dissertation wherein the "New Race" and Kabyle pottery are compared; the writers think that the modern Kabyle pottery is a survival of ancient Libyan pottery, and that because it is almost identical with that of pre-dynastic Egypt there must have been a close connection between the two countries in the most ancient times. There is a good deal of guessing in argument of this kind, and their assertion that the "hieroglyphic language is Semitic" is as bold and just as true as the criticisms of the writers on the Arabs and their character. They do not make this assertion except on the authority of Dr. Erman, who is a good Egyptian scholar, but then Dr. Erman is not a Semitic scholar in any sense of the word, and he has never shown that he has any competent knowledge of *any* Semitic language; on the other hand, Semitic scholars who have studied Egyptology *ad hoc* declare that the old language of the hieroglyphic inscriptions is not Semitic, and until we see further proofs adduced we shall hold that the Semitic scholars are right.

The chapter on rude stone monuments in Algeria summarises a good deal of general information obtained by the writers and others, and it is interesting to note that

Messrs. Randall-Maciver and Wilkin think that the burial practice of the Libyans links them to the early European races and to the Amorites of Syria; but it isolates them completely from the inhabitants of Egypt of any period, whether early or late. Moreover, they assert, as the result of their craniological investigations, that connection of culture gives little or no ground for inferring identity of race between the Egyptians and Libyans; and although they admit that the prehistoric Egyptians—by which they mean the Egyptians of the first three dynasties!—were a mixed race, they declare in no uncertain voice that this mixed race as a whole was not Berber. This conclusion is based on the difference between the cephalic index of the Egyptians and that of the Berbers, and is supported by a number of carefully constructed tablets drawn up on a system which we think is new. The supporters of the theory that the Egyptians were of Libyan origin will be somewhat disturbed by such deductions, but the last word on the subject has not yet been spoken, and it must be frankly admitted that such ingenious arguments and speculations as those set forth by such industrious writers as Messrs. Randall-Maciver and Wilkin only serve in the end to show the general reader how very little is really known about such remote times as those to which they relate.

"Libyan Notes" is an interesting book, not so much for the conclusions arrived at by the authors as for the facts and references to the works of older writers, and the plates contained in it. The "notes" are brightly written, and, as we should expect from Oxford men, some attention has been paid to the style of the English used in their composition. Unfortunately, they do not advance our knowledge of the difficult subjects discussed, and it is hard not to feel that the writers have unconsciously tried to make their facts "square" with too many theories about the origins of civilisation in Southern Europe and Northern Africa. A little more attention might have been given with advantage to the Arabic words and names, especially if quantities are marked; spelling like Hâjji (p. 7), Djemâa (pp. 18, 19), Oukil (p. 20), Zaouïa (p. 21), &c., disfigure the book.

OLD WEATHER RECORDS.

Meteorologische Beobactungen vom xiv. bis xvii. Jahrhundert. Mit einer Einleitung. Herausgegeben von Prof. Dr. G. Hellmann. Pp. 127. 4to. (Berlin: A. Asher and Co.)

THIS volume is the thirteenth of the series of reprints of texts and charts concerning meteorology and terrestrial magnetism published in Berlin under the editorship of Dr. Hellmann. The editor's previous achievements in the bibliography of meteorology are so conspicuous that it will not surprise any one to find that he has selected and arranged extracts from the earliest regular meteorological records in such a way as to produce a most interesting volume. His investigations have incidentally led to considerable additions to our store of knowledge of the meteorology of Europe during the centuries referred to, for inquiry among the libraries has proved the existence of a number of useful weather registers in the margins of old calendars. These doubtless owe their origin, as Dr. Hellmann suggests, to the curious combination of the dearness of paper and the prevalence of the notion of referring weather changes to astronomical causes not exclusively solar, a notion not even yet quite extinct. The index of meteorological observations in the fifteenth, sixteenth and seventeenth centuries accordingly occupies as much as twenty-six pages and becomes an important work of reference for the study of secular changes of climate.

The selection of extracts is thoroughly cosmopolitan. By the exercise of a little ingenuity Dr. Hellmann manages to include with the extracts from observations made in all parts of Europe, in America and on the seas, some information about the meteorological observations of the Chaldeans lately brought to light by Mr. R. Campbell Thompson's publication of the reports of the magicians and astrologers of Nineveh and Babylon. He has something to say too about Theophrastus' book of the winds, which has been translated by Mr. J. G. Wood, and also about some early rainfall measurements in Palestine on the authority of the Mishnah.

The extracts themselves begin with a weather journal for 1343, written in Latin by William Merle, of Driby (Lincolnshire), preserved in the Bodleian Library, and end with observations made in a voyage to China, A.D. 1700, by Mr. James Cunningham, F.R.S., a ship's log originally printed in the *Philosophical Transactions.* Among the names of other observers are Martin Biem, of Krakau (1502); Aventin, of Munich (1511); Pietramellara, of Bologna (1524); Palomino, of Jodar, Spain (1556); Tycho Brahe (1582); Kepler (1623); Marggraf, Brazil (1640); Campanius, of New Sweden, N. America (1644); the Florentine observers (1655); John Locke, of Oxford (1666); and Robert Plot, of Oxford (1684), who gives the earliest extant diagram of barometric changes. Among the early marine observers are Columbus (1535); John Davis (1506); Francis Drake (1596); Henry Hudson (1608); Abel Janszoon Tasman (1642); Friedrich Martens, an arctic traveller (1671); and Edmund Halley (1699), the first 'modern' writer on the general circulation of the atmosphere, whose observations were made on a special voyage of investigation of the ocean winds in the *Paramour Pink*, a vessel placed at his disposal by King William III.

The book is full of interest not merely historical. In view of the difficulty of consulting the originals for the purposes of inquiry into such questions as the periodicity of weather changes, it seems a pity that the material is not reprinted in full instead of by extract. But such a reprint would form an entirely different kind of book.

The volume, like its predecessors in the same series, is a sort of *édition de luxe*; it is beautifully printed on handmade paper and the facsimile reproductions are excellent.

OUR BOOK SHELF.

Le Coton. By Prof. H. Lecomte. Pp. viii + 494. (Paris: Carré and Naud, 1900.)

THIS is largely a work of compilation, and not the result of original research or experiment. In the first part, the methods of cotton culture and the chemical composition and physical structure of the fibres are dealt with. Comparisons are also made between the properties of different cottons and the uses and applications of the by-products, such as cotton-seed oil and its manufacture. The extent to which cotton is now being grown in the United States forms several chapters of considerable interest to those concerned in the extraordinary development of the cotton industry. The other countries of America in which cotton culture is practised are next referred to, such as Mexico, Brazil and Peru. Egyptian cotton, which is largely esteemed, according to the writer, has been principally developed during the last half of the 19th century.

Allusion having been made to the historical use of cotton in eastern countries, Madagascar and Persia, the cotton-growing districts of Asia are then referred to.

Some interesting information is supplied on the baling of cotton as effected in different countries, and on the principal cotton markets of the world.

In the second part of the book the writer reviews the general history of the development of the various branches of the cotton industry, following with an analysis of the trade and its growth as known in France. Similarly, with the progress in England, Austria and Russia, and the remarkable development in Japan.

The work is purely one for the statistician, only being of indirect utility to those engaged in the manufacture of cotton fabrics, or in any way users of the cotton plant. Still, to those who wish to have a comprehensive survey of the remarkable increase in the culture of the cotton plant in countries widely differing from each other in climate and customs, the book will be found invaluable.

ROBERTS BEAUMONT.

Taxidermy; Comprising the Skinning, Stuffing and Mounting of Birds, Mammals and Fish. Edited by P. N. Hasluck. Pp. 160. 12mo. Illustrated. (London: Cassell and Co., Ltd., 1901.)

THE foundation of this little treatise is a series of articles by Mr. J. Fielding-Cottrill—occupying, it is said, nearly twenty thousand columns—which have appeared from time to time in *Work*, and have been brought into their present form by the editor of that journal. In his preface the editor avoids any mention of the class of workers for whom the volume is primarily intended, and it is not easy to infer this from a study of its contents. Certainly the professional taxidermist, who has at his command works of the class of Mr. J. Rowley's "Art of Taxidermy" (reviewed in NATURE for 1898), has nothing to learn from the present handbook, and it is difficult to imagine in what way the ordinary amateur is likely to be interested in the mounting of animals of the size of a waterbuck (p. 49).

It is not as if the author (or editor) had any new ideas to communicate with regard to the mounting of such mammals. On the contrary, although he confuses his readers with an unnecessarily complex system of measurements to be taken before skinning, he is really far behind advanced modern methods in his system, which bears no comparison with that adopted by many Continental and American taxidermists. Indeed, mediocrity may, in our opinion, be regarded as the leading feature of the book; and nowadays we require something beyond this, at least for those workers who attempt the mounting of big game.

As regards the skinning and stuffing of ordinary birds and the smaller mammals, the methods and descriptions are, in an old-fashioned way, well enough; and had the editor restricted himself to work of this nature not much fault could be found with his attempt.

One thing we are glad to notice, namely, that the author advocates painting stuffed fish in imitation of their natural colours instead of being content with the faded scarecrows still to be seen in some of our museums. Whether, however, the methods, both of mounting and colouring, advocated by him would result in the production of specimens bearing any real resemblance to their living prototypes could be decided only by actual inspection of the work.

R. L.

A Treatise on Electromagnetic Phenomena and on the Compass and its Deviations aboard Ship. Mathematical, Theoretical and Practical. By Commander T. A. Lyons, U.S. Navy. Vol. i. Pp. xv+556. (New York: Wiley and Sons. London: Chapman and Hall, Ltd.) Price 25*s*. 6*d*.

THIS first volume, which is to be followed by a second devoted to ships' compasses, takes a wide sweep over physical science generally. Sound waves, light waves, kathode rays, Röntgen rays and Hertzian radiation are treated in a vigorous popular style, special attention being devoted to the functions of the ether which pervades all space. No preliminary knowledge is assumed, common language is preferred to technical, and much information of quite recent date is given—a notable instance being the information regarding atmospheric electricity obtained by kite-flying. The reader never feels himself snubbed as an ignorant person who must be content with elementary knowledge, but is freely admitted to the most sacred arcana.

On the other hand, little attention is paid to precision in the use of scientific language, and both grammar and logic are sometimes loose. Moment of inertia is spoken of as potential energy, and we are told that the field of a current can be measured in dynes; also that the moment of a magnet and the strength of a pole can each be expressed in dynes. On p. 152 the extraordinary statement is made that a steel magnet of suitable strength suspended by a thread between the poles of an electromagnet sets equatorially. As a matter of historic criticism, the discovery of "the dip" is claimed for Peter Peregrinus, simply because he observed that a suspended needle dipped when held over either end of a horizontal magnet.

About a third of the volume deals with magnetism, especially terrestrial magnetism and the instruments for measuring it—a subject with which the author appears to have much practical familiarity, being, it would appear, the founder of the Magnetic Observatory at Washington.

The Steam-Engine Indicator. By Cecil H. Peabody, Professor of Marine Engineering and Naval Architecture, Massachusetts Institute of Technology. Pp. 153. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1900.)

A USEFUL little treatise, easy to read and understand, and well illustrated. It has some defects. The error due to stretching of the cord is thought to be merely a cutting away of the two ends of the diagram, whereas the whole diagram is altered on account of the continuous change of length of the string as the pulling force alters through inertia of the paper barrel and friction. Again, friction of pencil on paper always keeps the diagram *larger* than it ought to be; the author says that it *reduces* the area. Too much space is devoted to the theory of the planimeter and other matters. The important relationship between natural period and time of revolution of engine is not touched upon.

Progress of Invention in the Nineteenth Century. By Edward W. Byrn, A.M. Pp. vii + 476. (New York: Munn and Co., 1900.)

THE author describes scientific discovery and invention from the point of view of a man familiar with the American patent office. Henry, and not Sturgeon, is therefore the inventor of the horse-shoe electro-magnet; Morse, and not Cooke, is the inventor of the telegraph. He has the patent office official's knowledge of science. He bursts into rhapsody only at the beginning and ending of chapters. He gives in each chapter bits of the history of an industry, not very satisfying because very incomplete. But each chapter is readable, being somewhat like an article in an illustrated magazine intended for general readers.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Vitrified Quartz.

I THINK Dr. Joly has misunderstood the abstract of my lecture. It is impossible not to feel confident that a transparent solid which has a very low coefficient of expansion, which expands very regularly up to 1000° C. and returns very exactly to its original volume when it is re-cooled, which remains unfused at 1500°, and which bears great and sudden changes of temperature with impunity, must, in the absence of any other really satisfactory material, prove very useful in its applications in thermometry.

The fact that "quartz fibres" are spoilt when they are reheated was well known before Dr. Joly read his paper on the subject. I believe it was first observed by Mr. Boys, and it is more than once referred to by Mr. Threlfall in "Laboratory Arts" (see pp. 116 and 119); but I do not find that vitreous silica in larger masses is equally sensitive, provided that it is protected, when hot, from the action of basic oxides; in contact with these it quickly becomes rotten when heated. This last fact suggests an explanation of the defect observed in the fibres. "Quartz fibres" are spun from vitreous silica in the plastic state when it is in contact with air which teems with dusty particles the dimensions of which are by no means negligible in comparison with those of the very attenuated fibres. Therefore it seems not unlikely that the fibres consist of less pure silica than larger masses of the material.

Those who work in silica should take care to use Brazil crystal as free as possible from alkali, for its melting point and other qualities may be expected to depend largely on its purity, and rock crystal from all sources is not equally pure.

Clifton, Bristol. W. A. SHENSTONE.

A Raid upon Wild Flowers.

IN the last number of NATURE (p. 118) you quote with approval the field studies in natural history, of which the Essex Technical Instruction Committee has issued a programme. I will ask space to state the grounds which lead me to regard this programme as an injury both to natural history and to education.

The teachers of Essex are invited to make a systematic raid upon our wild flowers, and especially upon such as are tending to extinction. They are to collect, name and dry, not only single specimens, but duplicates for "special fascicles." Local guides are to direct them to the last retreats of the rare plants of the New Forest. Nothing is more to be desired, in my opinion, than that the party may fail to discover the things which they most covet.

This eradicating scheme is utterly useless for scientific and educational purposes. There is no science in all this drying and naming. It is enough to condemn the programme as an educational project that novices, knowing little or nothing of field-botany, are set to study the subspecies of brambles! Two pages (14, 15) contain promising headings, but if the work is to be carried out in the spirit of the rest of the programme, this too will end in nothing better than schedules and fascicles and names.

I should be delighted to learn that the Essex Technical Instruction Committee had abandoned the whole scheme as destructive and educationally barren. L. C. MIALL.

P.S.—I have just been assured (June 4) that only advanced students will be allowed to see the rare plants of the New Forest; it is not stated whether they will be allowed to gather them. There was no such restriction in the printed programme. My other objections remain.—L. C. M.

THE programme criticised by Prof. Miall is unofficial so far as the Essex Technical Instruction Committee is concerned. It was not considered by the Committee or by any sub-committee before publication. It is needless to say that, although I am myself a member (co-opted) of the Committee, I am thoroughly in accord with the general spirit of the above criticisms. On carefully considering the programme in detail I am, however, bound to point out that there are several misconceptions in Prof. Miall's letter. The programme was drawn up by the Staff Instructor in Biology, Mr. David Houston, and he is alone responsible for its contents. He will, I am sure, be able to give a satisfactory explanation concerning many of the charges brought against his scheme. My only object in availing myself of the courtesy of the Editor is to remove the impression that the programme is officially authorised by our Committee.

R. MELDOLA.

The Reported Earthquakes in the Channel Islands and South Devon on April 24.

IN a recent letter to NATURE, the Hon. Rollo Russell refers to some supposed earthquakes felt along the coasts of the English Channel on April 24. As accounts of them have also appeared in several London and provincial papers, it may be worth while to state briefly the results of my inquiries.

The disturbances bear a strong resemblance to those caused by the firing of distant heavy guns. Between about 1 and 1.45 p.m. five shocks were felt in Guernsey, and eight at Paignton in South Devon. They were of very short duration; windows were shaken, but there was no perceptible tremor of the ground. Observers in Guernsey compared the sounds to thunder or the firing of very heavy guns; but those on the English coast seem to have been generally unconscious of any sound. Yet the impression of an observer at Salcombe was that a cannon had been fired to the south, but "too far away to bring the noise."

Trials with heavy guns are said to have been made along the coast of France on April 24. I have not succeeded in ascertaining the place or time of the firing; but that the report assigns a possible cause of the supposed earthquakes will, I think, be evident from the above account. CHARLES DAVISON.

Birmingham, May 29.

Foreign Oysters acquiring Characters of Natives.

MAY I call attention to some curious facts with regard to oyster culture? I do not know whether the evolution they undergo is brought about by Lamarckian factors, or whether it is brought about by natural selection, but no doubt a correct interpretation could be given by some of your readers.

The facts are as follows:—Oysters of the species *Ostrea edulis*, one year old, are brought from Brittany, in France, and transplanted at Hayling Island. After two years on the Hayling beds they are transferred to Whitstable. While they are at Hayling they acquire the characteristics of flavour, and texture and colour of shell of the oysters native to Hayling, yet they are distinguishable as originally from Brittany. When they are transferred to Whitstable they acquire the characteristics of Whitstable, yet they are distinguishable as originally from Hayling and Brittany, and are quite distinct from oysters native to Whitstable. Sometimes they have been brought direct from Brittany and laid at Whitstable for three or four years, and, although all the new growth they acquire is characteristic of Whitstable, yet they are distinct from Whitstable natives, and can be easily detected by experts.

Now the curious point is this: these oysters are known to spawn at Whitstable, yet oysters "spat" from this spawn have never been found. There are found, however, especially the last few years, immense quantities of oysters which resemble the ancient native oysters of Whitstable, and are declared by experts to be Whitstable natives, yet differing from them slightly in coarseness of shell and greater growing power, and in being more susceptible to cold weather than the ancient Whitstable natives. Amongst oyster experts these oysters are considered to be the offspring of the oysters originally brought from Brittany, and this opinion is supported by the fact that when these oysters spawn at Hayling the spat from them resemble in every way the oysters native to Hayling. Can the oysters that become changed in this way be considered to have acquired their new characteristics by Lamarckism or by natural selection?

London, May 22. J. M. TABOR.

The Cape Viper.

TO-DAY the Cape viper (*Causus rhombeatus*) laid several eggs. The keeper says this has happened before. As Causus is one of the Viperidæ, and as the Viperidæ (except Atractaspis) are, as their name implies, viviparous, or, to be accurate, ovo-viviparous, it would be interesting to know whether this is a freak, or whether the Causidæ are oviparous in their native state.

CLAUDE E. BENSON.

5 Elvaston Place, Queen's Gate, S.W., May 15.

SOME SCIENTIFIC CENTRES.

I.—THE LEIPZIG CHEMICAL LABORATORY.

LEIPZIG is a city which boasts many traditions; it is associated with some of the most distinguished names in nearly every department of intellectual life; and its University justly takes a place among the leading schools of Europe. To us there is a sense of fitness in the thought that the school which produced a Wagner and a Goethe should have numbered among its teachers two men who have left a mark in the history of the development of organic chemistry. These men are Hermann Kolbe and Johannes Wislicenus; both of them famous as teachers and experimenters, and each of them associated with a theory the importance of the effect of which on the growth of their science it would be difficult to overestimate.

Wislicenus succeeded Kolbe in the chair at the University of Leipzig, and Wislicenus still works in the laboratory which was made famous by his predecessor; he is the oldest survivor of that generation of workers who laid the foundations of organic chemistry, and as such and as a mark of esteem by one of his old pupils, his laboratory has been chosen as the first of the present series.

The laboratory in Liebig Strasse, which has been the scene of so many classical researches, was built by Kolbe, who commenced to work there in the autumn of 1868.

His name was already famous in connection with his earlier work on the determination of the nature and chemical constitution of organic radicles, in which he was materially assisted by the researches of Frankland. But it was in Leipzig that his most brilliant experimental work was carried out; it was there there that, in conjunction with Drechsel, he synthesised oxalic acid from carbon dioxide and potassium, and, assisted by Basaroff, obtained carbamide by the interaction of carbon dioxide and ammonia. Among the early achievements which have invested the present laboratory with such historic interest, and entitle Kolbe to a place among the "wahre Bearbeiter," of Berzelius—to whom, indeed, as well as to Liebig, Wöhler and Bunsen, he used to ascribe his inspiration—must be mentioned the synthesis of isosuccinic acid, the production of nitromethane from chloracetic acid, and the famous reaction for obtaining salicylic acid by the action of carbon dioxide upon sodium phenate, in which he disclosed the singular fact that the use of potassium phenate resulted in the formation of the isomeric para-hydroxybenzoate.

Kolbe died on November 24, 1884. He was not mourned by all who knew him, for his pen had made him not a few enemies; his violent attacks on the "Structurchemiker," and his description of Kekulé's theory of the benzene ring as "wilde Phantasien ohne reelle Basis," have become part of the history of chemistry; while his allusion to the since illustrious van 't Hoff in the words "Ein Dr. J. H. van 't Hoff, findet wie es scheint, an exakter chemischer Forschung keinen Geschmack. Er hat es bequemer erachtet, den Pegasus zu besteigen, und in seiner 'La Chimie dans l'espace' zu verkünden, wie ihm auf dem durch kühnen Flug erklommenen chemischen Parnass die Atome im Weltraume gelagert erschienen sind," was almost worthy of Swift himself.

Wislicenus was appointed director of the laboratory in October, 1885, and effected several alterations in its interior to increase the facilities for work. The number of students rapidly increased till it reached the maximum that the building could accommodate; and in spite of the counter attractions of the Physical Chemistry Institute, which was opened in 1871, the popularity of the first laboratory never waned. At the present time there are 174 students working there, of whom 50 are engaged in carrying on research under the direction of Prof. Wislicenus and his assistants.

Before going on to describe the researches which have maintained the traditions of the laboratory, a brief glance at the career of Johannes Wislicenus will assist us in forming some idea of the nature and variety of his experience.

Born in 1835 in Saxony, the son of a pastor, he received his education first at a school in Halle, and then in 1853 at the University of the same town, where he commenced to study science. But those were the years of revolutions, and in the following autumn his father was forced, on account of his political opinions, to fly to America; there the young Johannes obtained an appointment as assistant to Prof. Horsford at Harvard University, and one year later was made lecturer at the Mechanics' Institute, New York, with a laboratory at his disposal.

In 1856 he returned with his family to Europe, resumed his interrupted studies at the University of Zurich, and later on at Halle; in 1860, he "promovirte, and was appointed 'Privat-docent' at the Zurich Polytechnic." In 1865 he was called to the chair of chemistry at Zurich University, and six years later became director of the Polytechnic. The years 1872-1885 were spent as professor at Wurzburg, where he succeeded Ad. Strecker. On the death of Kolbe the vacant chair at Leipzig was offered him and accepted; and there is a curious irony in the thought that his first work there should have been directed towards the extension of the theory of that van 't Hoff whom his predecessor had regarded with such contempt.

The work of Wislicenus has been confined almost entirely to the domain of organic chemistry. He entered the field when the "Radical Theory" of Kolbe and Frankland had taken a firm hold on the minds of the newer school of chemists.

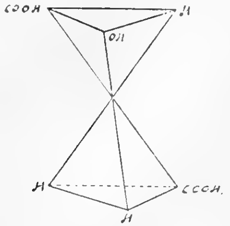
One of the first problems he attacked was the constitution of lactic acid; while still at Zurich he effected its preparation artificially from propionic acid as well as from aldehyde (*Liebig's Ann.* 1863, cxxviii, 11; cxxxiii, 257; and cxlvi, 145). Later on he succeeded in establishing the identity of structure for the two different substances fermentation- and para-lactic acids (*Liebig's Ann. Chem.* 1872, clxvi, 3; and clxvii, 302). The structural theory alone was thus insufficient to explain such cases of metamerism. He was impelled, therefore, even as early as 1873, to the conclusion that the cause of the difference between the two acids must be looked for in the spacial relations of the atoms in the molecule.

But his attention was for a time diverted from this topic by the classical researches which he was carrying out on acetoacetic ether; his chief papers on the subject appeared in 1877 (*Ann. Chem. Liebig*, clxxxvi, 163; cxc, 257; 1881, ccvi, 308). He studied in detail its reactions, mode of preparation and decomposition, and showed it to be the most valuable synthetic agent then known. His work was of the utmost value in throwing light on the still debated constitution of the substance; in it he was assisted by several English students who have since attained eminence.

Wislicenus was now the occupant of the Leipzig chair; after several papers of lesser importance had appeared, he challenged the attention of the world by the publication, in 1887, of the famous memoir: "Über die raümliche Anordnung der Atome in organischen Moleculen." In this he put forward an explanation of what he termed geometrical isomerism, which was an extension of the hypothesis formulated independently by Le Bel and van 't Hoff in 1874. According to this hypothesis "the centre of gravity of a carbon atom was regarded as situated in the centre of a tetrahedron, and its four affinities at the four corners." When two atoms were linked together, van 't Hoff, and after him Wislicenus, assumed that both were capable of rotating in opposite directions about a common axis; this possibility ceased, however, with a double or treble linking of the carbon atoms. Wislicenus further called into play the action of certain "specially directed forces, the affinity energies," which determine the relative positions of the atoms to one another in the molecule.

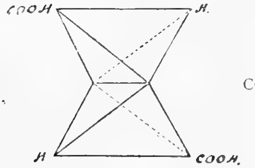
Space will not permit of any detailed discussion of this theory; a single example must suffice to illustrate the manner in which it was applied by Wislicenus.

By heating malic acid to 150° on an oil bath, it is converted almost entirely to fumaric acid; this he explained by the diagrams



= H_2O +

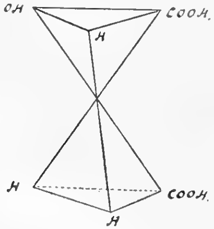
Malic Acid



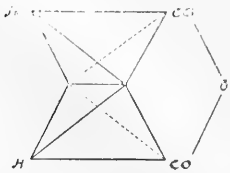
COOH

Fumaric Acid.

If the malic acid be heated from 170—200°, small quantitities of maleic anhydride are formed, though even at this temperature the greater part is converted as before to fumaric acid; this, according to the theory, is due to the existence in the malic acid at the higher temperature of a certain number of molecules in which the atoms have swung round and assumed the positions indicated below; from which the formation of maleic anhydride might be predicted:



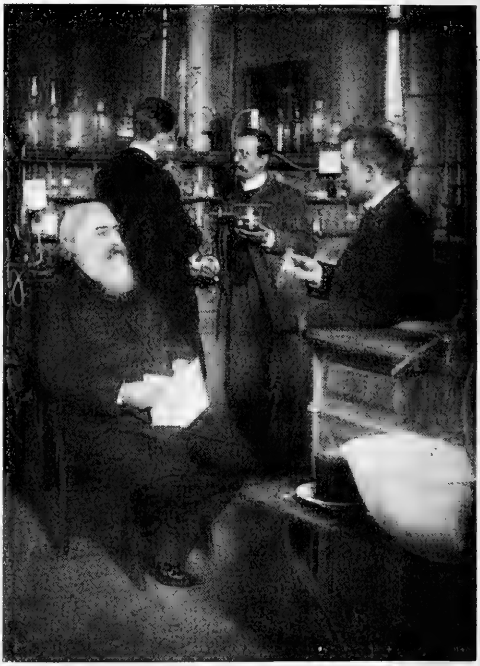
= $2H_2O$ +



Maleic Anhydride.

In the same way Wislicenus applied his theory to all the other reactions of maleic and fumaric acids, to the tolane dichlorides and dibromides, mesaconic and citraconic acids, the crotonic acids, &c; among all the cases he considered, there were only two facts not in consonance with those demanded by the theory; these were (1) the partial conversion of maleic into fumaric acid by the action of bromine, and (2) the production of dibromfumaric acid by the addition of bromine to acetylene-dicarboxylic acid.

In the following year (1888) he published a series of papers (*Liebig's Ann. Chem.* 1888, ccxlvi, 53; ccxlviii, 1; 1889, ccl, 224; cclxxii, 1) containing the results of a large number of experiments (carried out by himself and his pupils) with the object of investigating the nature, constitution and relationships between maleic and fumaric acids, acetylene-dicarboxylic acids, the



Wislicenus in his laboratory.

α-chlorpropylenes, the crotonic acids, the tolane dichlorides, &c.; all of these tended to support the hypothesis he had put forward. In the case of the two apparent exceptions alluded to above, he showed that in the first case the action is far more complicated than at first appears, the conversion of the maleic into fumaric being wholly accounted for by the formation of hydrobromic acid in the course of the reaction, which would suffice to bring about the change. Similarly in the second case, by preventing the formation of hydrobromic acid, the reaction is that demanded by theory, viz., the formation of dibrom maleic acid. Thus the exceptions strengthened rather than weakened the argument.

It is only fair to call attention to the fact that Michael, who has devoted considerable time to the investigation of the subject, has obtained results which in many cases are not explained by the theory of Wislicenus and van 't Hoff (*Journ. Prac. Chem.* 1895, [2], lii, 365–372); but, as was shown in the celebrated controversy with Fittig (*Liebig's Ann.* 1892, cclxxii, 1-99) over the brom-additive products of angelic and tiglic acids, the conditions of the experiment play such an important part in determining the nature of such reactions that the bearing of the results on the validity of the theory must be accepted with a certain amount of reservation. The matter is still the subject of discussion; for the present we can only quote the words of an illustrious chemist, who said that "unter allen sonst vorgebrachten Erklärungs-versuchen lehrt kein einziger auf gleich einfach und gleich umfassende weise die beobachteten Thatsachen verstehen."

Wislicenus has of late been engaged in the application of the theory of spacial relations to the formation of ring compounds, his synthesis of cyclo-pentanone from the calcium salt of adipic acid serving as a starting point in the preparation of the simplest five-ring compounds. Especial interest attaches to the investigation of suberone, which was shown to be a seven carbon ring; for the theoretical consideration of von Baeyer (*Ber.* 1885, xviii, 2277), in addition to those already referred to, would make us regard a seven carbon ring as unstable as a four.

Wislicenus is one of the forty foreign members of the Royal Society, and was awarded the Davy medal in 1898. Still working with all the vigour of an enthusiast, lecturing both in summer and winter at eight o'clock, making frequent tours through the research laboratories with his note-book and cigar, and listening patiently to the "Ausländer" who bury their unsuccessful experiments in the mysteries of the German language, he attracts students of every nationality, for he has a personality which makes its influence felt; and those who have enjoyed the privilege of working under him have lost none of their respect for a distinguished teacher in their appreciation of his kind hospitality and generous spirit.

THE CENTENARY OF THE DISCOVERY OF CERES.

A HUNDRED years have passed since Piazzi, at Palermo, opened a new era in observational astronomy by the discovery of the first of the many small planets that circulate between the orbits of Mars and Jupiter. This welcome, but not unexpected, addition to the known members of the solar system gave an increased interest to the routine of observation, supplied fresh reasons for the preparation of accurate star catalogues, and quickened the researches of practical astronomy, a little overshadowed by the brilliancy of the results won on the physical side by the French mathematicians of the last century. It is true that within the space of time which has elapsed since Piazzi used to such good purpose the altazimuth of Ramsden, the history of astronomy has had to record, not only the growth, but also the decrease, of interest which has been a consequence of the rapid discovery of similar objects. Nevertheless, Piazzi's discovery was fortunate and fructiferous, and we willingly associate ourselves with those of his countrymen who have recently sought to do honour to his memory and to demand due recognition for his services. We are reminded, in a recent number of *Memorie della Societa degli Spettroscopisti Italiani*, that though the story of the discovery of Ceres may have been frequently told and is very well known, yet there are features connected with it of which we may well be reminded. For eight years with untiring diligence did Piazzi patiently work, before he made the discovery which has rendered his name a household word and endeared his memory among his countrymen. Doubtless he himself considered his star catalogue a far greater work, and so posterity will esteem it; but the renown that attaches to such a discovery is immediate and, in a sense, abiding. To appreciate fully what it meant at the time, we must recall the confidence and the agitation which were connected with the so-called Bode's law. The evidence such a formula offered of the existence of an undiscovered planet may not appear now very convincing, but the confidence with which it had been received had been strengthened by the comparatively recent discovery of Uranus, and astronomers, among whom may be reckoned Schrœter and De Zach, were banded together with the firm determination to discover the missing link in the chain of planetary distances. Piazzi, according to Grant, stood outside this company of eager astronomers, but the late Admiral Smyth, who had exceptional information from his personal acquaintance with Piazzi, gives him a place in the circle. In any case it was due to systematic work diligently pursued by the Palermo astronomer that the prize was won.

But, as pointed out by Prof. Angelitti and others who have taken part in the centennial celebrations, the indirect results of the discovery have far outweighed the immediate. Among these may be reckoned the earlier publication of the "Theoria Motus" of Gauss, and especially those chapters which deal with the computation of an elliptic orbit from observations that embrace only a short interval of time. This classical work has remained for a century, the model on which all similar calculations have been based. Alterations of detail have been introduced from time to time bearing upon special parts of the work, but practically the method followed to-day is the method that Gauss evolved to rescue and identify the discovered planet of Piazzi from the stars by which it is surrounded and which it so much resembles. It is well known that Ceres, as the small planet was called, was followed by Piazzi only from January 1 to February 11. Oriani and Bode, to whom Piazzi forwarded his observations, do not appear to have seen the planet in the first year of its discovery, and Gauss' researches and the success that attended them rest entirely on the labours of the original discoverer.

It is not out of place to recall how the discovery of small planets and the eagerness with which they were sought in the middle of last century gave a great impetus to the construction of accurate maps of the heavens. The Berlin charts led to the ready recognition of Neptune, while the ecliptic charts of Hind, of Peters, of Chacornac and of a host of others who engaged in the work, added greatly to our knowledge of the configuration of the heavens and the arrangement of the stellar universe. And it must be remembered that one of the first, if not the first, valuable application of photography to astronomy had for its aim the rapid delineation of such charts originally devised for the detection of small planets. To the fruitfulness that has followed this peculiar direction of thought it is not necessary to refer more particularly, but it would not be difficult to show that the discovery of small planets, originating in the small observatory of Palermo, has exercised an enormous influence on the methods of observation now so generally pursued.

We need do no more here than barely refer to the important part that the group of small planets has played in the oldest of old problems, that of the distance of the Sun. Let the bulky volumes that Sir David Gill has sent from the Cape speak of the work that small planets have furnished to the astronomer in this chapter of his science. And now, practically a century after Piazzi taught us how the space between Mars and Jupiter is crowded with cosmical matter, we find astronomers of all nations cooperating on the systematic observation of one of these small bodies, only intent upon bringing the new material to aid more efficiently in the serivce of the old. Small planets have played, and in the future will continue to play, a part in the onward progress of astronomy, and for this reason we think Italian men of science are well advised to insist upon the recognition of the services of their famous countryman, and they may be assured that all who value solid work diligently performed will give a grateful thought to the unostentatious astronomer of Palermo, who devoted himself with skill and patience to the laborious, and perhaps unappreciated, work of cataloguing the stars. W. E. P.

SYNTONIC WIRELESS TELEGRAPHY.

MR. MARCONI'S lecture on "Syntonic Wireless Telegraphy," recently delivered before the Society of Arts, gives an admirable and most interesting description of the system which he has developed and of the steps by which the development has been effected. "I have come to the conclusion," said Mr. Marconi, "that

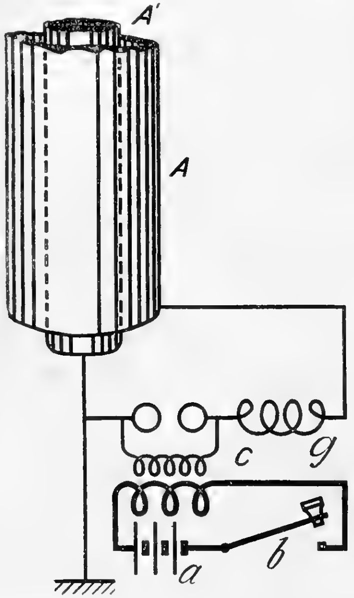


FIG. 1.

the days of the non-tuned system are numbered." If this prophecy be correct the non-tuned system has had, as was indeed expected, but a short life; but even in the few years that it has been in use it has accomplished much, having already to a certain extent greatly increased the pleasure and, above all, the safety of travelling by sea. There can be no better evidence of the general utility of wireless telegraphy than that the time has already arrived when the imperfections of the untuned system are making themselves felt. To quote Mr. Marconi again, "The ether about the English Channel has become exceedingly lively, and a non-tuned receiver keeps picking up messages from various sources which very often render unreadable the message one is trying to receive." That this confusion of messages would sooner or later occur many prophesied in the early days of the art, but few, we think, seriously believed that it would come about so soon. Fortunately, now that the evil is beginning to be felt, Mr. Marconi is ready with the remedy, a well-worked-out and trustworthy system of tuned transmitters and receivers.

The original form of Mr. Marconi's transmitting arrangement is too well known to need illustration: it consisted of an induction coil the secondary terminals of which were connected to a spark gap between two brass balls, one of these being earthed and the other connected to a long aërial conductor. Such a transmitter has a very low electrical capacity, and its radiating power is comparatively great. As a result, the oscillations which take place are considerably damped, and all the energy is radiated in one or two strong swings. Any receiving apparatus in the neighbourhood which is sufficiently sensitive will respond to these radiations even although its natural time of vibration differs greatly from that of the transmitter. Selection of messages with this arrangement is possible, to a limited extent, by using aërial conductors of considerably different lengths and

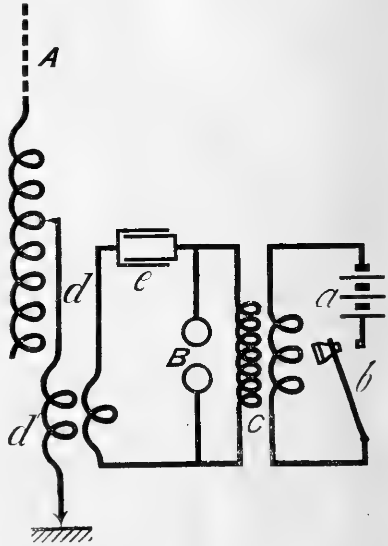


FIG. 2.

by winding the induction coils on the receiving apparatus with the length of wire necessary for correct resonance. But although this answers when the two or more transmitting stations are at different distances from the receiving station, it has been found not to work satisfactorily when the distances are equal.

It is necessary, therefore, to employ some form of radiator in which the oscillations are less damped and which will therefore emit a train of waves instead of one or two strong vibrations. These feebler impulses, falling in succession upon a receiver having the same time of vibration, will get up a swing sufficiently strong to break down the high resistance of the coherer. If, however, the receiver is not in tune, the impulses will not tend to get up any swing, and, being individually too feeble to break down the coherer's resistance, no signal will be recorded. Such a radiator can be constructed as shown in Fig. 1, in which the aërial conductor takes the form of two concentric cylinders, the inner, A', being connected to earth and to one side of the spark gap, and the outer, A, being connected through an inductance, *g*, to the other side of the spark gap. Mr. Marconi finds it essential that the inductance of the two conductors A and A′ should be unequal, the larger inductance being preferably joined to the non-earthed conductor A. Such an arrangement proves both a persistent vibrator and a good radiator, thus enabling selective signalling to be easily carried on over considerable distances with quite short heights of cylinder. Very good results were obtained between the Isle of Wight and Poole, a distance of three miles, with cylinders 1·5 metres in diameter and only 7 metres high.

Another very good syntonised transmitting and receiving system which has been devised by Mr. Marconi is shown in Figs. 2 and 3.

In this the terminals of the spark gap, B, are connected to a closed circuit containing inductance and capacity; such a circuit is a very persistent oscillator, but a bad

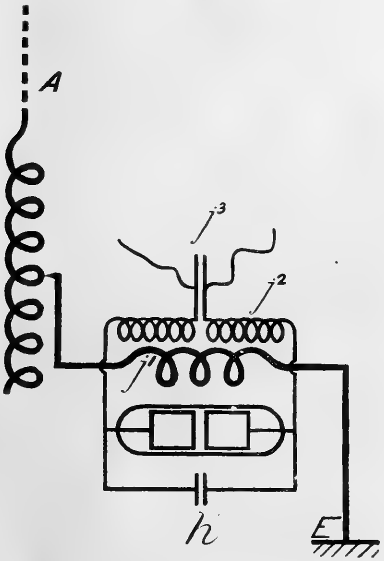


FIG. 3.

radiator and absorber. There is, therefore, combined with it a good radiating circuit, consisting of the vertical conductor, A, which is earthed through an adjustable inductance, *d*. The vibrations set up in the primary circuit connected to the spark gap induce oscillations in the radiating circuit, the mutual action being increased by winding a part of the radiating circuit around the primary circuit (at *d′*), as in a transformer. The two circuits are carefully tuned by adjusting either the capacity, *e*, or the inductance, *d*, or both. In the receiving apparatus (Fig. 3) the connections are similar; the aërial wire is connected to earth through an adjustable inductance, part of which, j^1, is wound as the primary of a transformer of which the secondary, j^2, is connected to the coherer; an adjustable capacity, *h*, is connected across the coherer in order to obtain better tuning. It will be seen that with this arrangement of transmitting and receiving stations there are four distinct circuits, two at each station, which have all to be in tune. Using this system Mr. Marconi has been able to attain very satisfactory syntony even although the same vertical wire be used for the different sets of signalling apparatus, which would be connected to it, in such a case, through inductances of different values.

A still further improvement is effected by combining the two methods described above; in this case the connections are made as shown in Fig. 4, which does not require any further explanation.

Mr. Marconi concluded his lecture with an account of some of the achievements already made with wireless telegraphy. The development has been so rapid under his able guidance that one feels that almost as one writes the systems being described are becoming out of date. Perhaps before long Mr. Marconi will have succeeded, by the use of suitable mirrors and lenses, in guiding the radiation in a definite direction, and thus

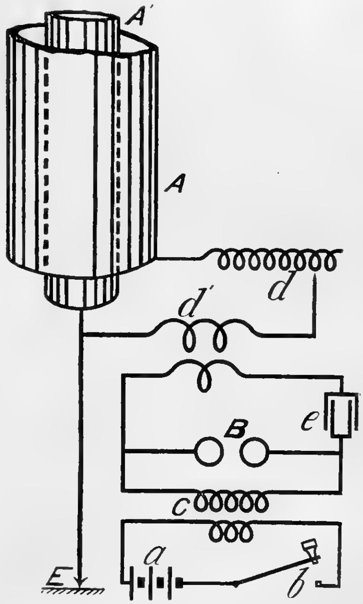


FIG. 4.

have effected a great gain in efficiency. But whether this should prove practicable or not, Mr. Marconi is to be congratulated on the brilliant success of his efforts, and deserves the gratitude of all for having worked out so admirable a system for increasing the safety and convenience of those "that go down to the sea in ships, that do business in great waters."

THE ANTARCTIC EXPEDITION.

TO our great regret the officers of the Royal Society have not yet, so far as we know, made any statement regarding the hopeless condition of affairs which has arisen in relation to the Antarctic Expedition in consequence of the recent action of the Council.

It will be of interest to our readers to observe, in the paragraph we quote below, from *Science* of May 24, the manner in which the management of the Antarctic Expedition is regarded by the scientific men of another nation. The writer has made a natural mistake in supposing that the expedition is under naval control and will sail under naval discipline. This of course is erroneous. The Admiralty has no responsibility and the expedition must be regarded as a private venture. As it stands at present, the expedition is to leave our shores without a man on board who has had any experience in the conduct of a scientific expedition of any importance; and without a commander who has had any experience in the control of a ship. Can the Royal Society bear the onus of responsibility which such a so-called "scientific" expedition will entail upon them?

"Dr. J. W. Gregory, who was appointed scientific leader of the British Antarctic Expedition and as such recently contributed to NATURE a plan of the scientific work, has now stated that he cannot accept service under the regulations laid down. This resignation, for so it has been regarded by the committee, is a very severe blow to the prospects of the expedition, or at least to the scientific results that might have been expected. Some, perhaps, prophesied failure when they saw the attempt that was made from the first to place the expedition under Admiralty control and naval discipline. Friction and consequent heat became inevitable when the committee proceeded to appoint two leaders—a naval and a scientific—without defining their powers from the outset. It is well known that the meetings of this committee have been a series of fights between the geographers and naval men as opposed to the purely scientific men; and Dr. Gregory has over and over again been on the point of resigning. We understand that the ultimate dispute was over the question of landing, which Dr. Gregory wished to have fixed as a main object of the expedition, and not left entirely to the discretion of an unscientific commander. But the actual cause of rupture is immaterial. The position, thanks to the naval manœuvres, has always been an impossible one for the scientific men. While Dr. Gregory's absence in Australia has placed him at a disadvantage, Sir Clements Markham may be congratulated; but the committee will have a difficulty in finding a head for the scientific staff with half the competence of Dr. Gregory."

NOTES.

CAPTAIN E. W. CREAK, F.R.S., has been created a Companion of the Order of the Bath "in recognition of his services while holding the appointment of Superintendent of Compasses in the Hydrographic Department of the Admiralty."

THE Bakerian Lecture of the Royal Society will be given by Prof. J. Dewar, on Thursday next, June 13. The subject will be "The Nadir of Temperature, and allied Problems."

WE regret to see the announcement of the death of Prof. J. Viriamu Jones, F.R.S., principal and professor of physics in the University College of South Wales and Monmouthshire. Prof. Jones was only forty-five years of age.

THE subjects of two of the evening discourses to be delivered during the forthcoming meeting of the British Association at Glasgow have been decided. Prof. W. Ramsay will lecture on "The Inert Constituents of the Atmosphere" on Friday, September 13, and Mr. Francis Darwin will lecture on "The Movements of Plants" on Monday, September 16. As already announced, the lecture to workmen on Saturday, September 14, will be delivered by Mr. H. J. Mackinder.

AN International Congress of Historical Science will be held at Rome in April of next year. There will be a section for the history of science, including especially medical science, and all who are interested in this or other sections of the work of the Congress are invited to communicate with Prof. P. Giacosa, Istituto di Materia Medica, Corso Raffaello 30, Turin.

PROF. WILLIAM GALLOWAY, professor of mining at the University College of South Wales, at Cardiff, has been appointed to investigate on behalf of the Government the cause of the Senghenydd explosion. Prof. Galloway has stated to a correspondent that it was unquestionably a coal-dust explosion, but more he could not say at present. As to the scope of the inquiry, he said specific points had been suggested by the Home Secretary, and the object of the scientific investigation would be to devise means to prevent a recurrence of the accident.

LORD GEORGE HAMILTON has written to Sir Alfred Hickman, M.P., ex-president of the British Iron Trade Association, explaining why certain contracts were placed by Indian railway companies with American firms. In the course of his remarks he says:—"You seem to think that orders have only gone abroad because those who gave them did not understand their business. I wish that it were so. The competition we have to face is founded on something much more formidable and substantial. Chemical research, concentration of capital, thorough technical education, improved industrial organisation have made in recent years greater advance in America than here; it is with the product of these combinations and not with the assumed stupidity of Indian officials that the British engineer has to contend." Sir Alfred Hickman replies in a long letter, which appeared in Tuesday's *Times*, but his remarks refer more to alleged imperfections in American work and the value of protection than to the cause of competition. He asks what evidence exists of "superior chemical research, technical education, &c.," and says, "I deny the 'chemical research'" mentioned by Lord George Hamilton. Apparently Sir Alfred Hickman attaches no importance to such reports as those prepared for the University of Birmingham and the Manchester Technical Education Committee as to the position of technical education in the United States; and he can scarcely be familiar with American scientific and technical publications or he would not "deny the chemical research" with so free a mind. It seems pretty clear, however, that the India Office official who wrote Lord George Hamilton's letter to Sir Alfred Hickman was not the one who expressed views about the chemistry at Coopers Hill and aided the efforts which have strangled the technical education of the officers of the Indian Public Works Department.

THE annual meeting of the Victoria Institute will be held on Monday next, June 10. Sir Robert Ball, F.R.S., will deliver an address.

THE Melbourne correspondent of the *Times* states that Prof. Baldwin Spencer's ethnological expedition, which has arrived at Alice Springs, 1000 miles south of Port Darwin, has obtained valuable photographs of the native war and other dances and sacred ceremonies.

SOLITARY specimens of the Hoopoe are not unfrequently seen on Lundy Island in the spring. A correspondent asks whether any reader of NATURE can explain their appearance or give any information about their nearest abiding place.

WE learn from *Science* that at the recent annual meeting of the American Academy of Arts and Sciences it was unanimously voted to award the Rumford medal to Prof. Elihu Thomson "for his inventions in electric welding and lighting." The Academy has granted to Prof. Theodore W. Richards, of Harvard University, the sum of 500 dollars from the income of the Rumford fund in aid of a research upon the Thomson-Joule effect.

AT the annual meeting of the Institution of Electrical Engineers on Thursday last, it was announced that the council had awarded the following premiums, among others, for papers and communications:—The Institution premium, value 25*l.*, to Mr. M. O'Gorman for his paper entitled "Insulation on Cables"; the Paris Electrical Exhibition premium, value 10*l.*, to Mr. W. Duddell for his paper entitled "On Rapid Variations of the Current through the Direct-Current Arc"; the Fahie premium, value 10*l.*, to Mr. A. C. Eborall for his paper entitled "Some Notes on Polyphase Substation Machinery"; and an extra premium, value 10*l.*, to Mr. J. S. Highfield for his paper entitled "Storage Batteries in Electric Power Stations controlled by Reversible Boosters." Salomons scholarships, value 50*l.* each, have been awarded, one to Mr. J. D. Griffin and one to Mr. H. A. Skelton. The sum of 2000*l.*, bequeathed by the late Prof. Hughes to found the David Hughes scholarship in the Institution, has been received from the executors, and the council has determined that, for the present, the manner of award shall be the same as that of the Salomons scholarship. Mr. C. J. Hopkins has been selected as the David Hughes scholar for the present year, the amount of the scholarship being 50*l.*.

THE celebration of the ninth jubilee of the University of Glasgow will commence on Wednesday next. The following programme has been arranged:—Wednesday, June 12, 10.30 a.m., commemoration service in the cathedral (University officials, guests and delegates are expected to attend in their academic robes or official costume); 2.30 p.m., reception of guests and delegates by the chancellor in the Bute Hall, and presentation of addresses; 8.30 p.m., "at home," Queen Margaret College; 9 p.m., students' gaudeamus in University Union. June 13, 10 a.m., orations in the Bute Hall: Lord Kelvin on "James Watt"; Prof. Smart on "Adam Smith"; followed by conferring of honorary degrees; 3 p.m., opening of the new botanical buildings by Sir Joseph Hooker; 4 to 6 p.m., garden party at Queen Margaret College; 9.30 to 11.30 p.m., conversazione in the Bute Hall, Library and Museum. June 14, 11 a.m., oration in Bute Hall: Prof. Young on "William Hunter," followed by organ recital; 3 to 5 p.m., "at home" in Art Galleries, International Exhibition; 7 p.m., banquet by corporation in municipal buildings; 9 p.m., students' ball in the Bute Hall. June 15, 10 a.m. to 5 p.m., excursion on the Firth of Clyde. Delegates will be present from Austria-Hungary, Belgium, France, Germany, Holland, Italy, Russia, Sweden, Switzerland and from Australia, Canada and India. All the Universities in the United Kingdom will be represented, as well as scientific and other institutions.

THE number of experiments performed on living animals in England and Scotland during the year 1900, under licences granted for that purpose, is given in a parliamentary paper just issued. Mr. G. D. Thane, inspector under the Cruelty to Animals Act, states in his report that the total number of licensees was 247, of whom 63 performed no experiments; that licences and certificates had been granted and allowed only upon the recommendation of persons of high scientific standing; that the licensees were persons who, by their training and education, were fitted to undertake experimental work and to profit by it; and that all experimental work had been conducted in suitable places. The total number of experiments was 10,839, few of which were in any serious degree painful. The experiments performed under licence alone, or under the certificate "permitting experiments in illustration to lectures," together amounting to 1299, were unattended by pain because the animal was kept under an anæsthetic during the whole of the experiment, and must, if the pain was likely to continue after the effect of the anæsthetic had ceased, or if any serious injury had been inflicted on the animal, be killed before it recovered from the influence of the anæsthetic. In 586 additional experiments the operations were performed under anæsthetics, from the influence of which the animals were allowed to recover. The operations were performed aseptically, and the healing of the wounds, as a rule, took place without pain. If the antiseptic precautions failed and suppuration occurred, the animal was required to be killed. These operations as now practised were seldom, if ever, followed by pain. It is stated that in a large proportion of the inoculations the result was negative—that was, the animal did not exhibit any ill effects, and therefore did not suffer any pain. That was especially the case with many inoculations for purposes of diagnosis, with the great majority of the inoculations performed for the testing of articles of food, and with many of the inoculations made for the purpose of standardising antitoxic serum—namely, those cases in which the antitoxin was sufficiently powerful to neutralise the amount of toxin injected, so that the latter had no action. Only a small proportion of the inoculations practised were followed by disease or poisoning.

SINCE the publication in NATURE (vol. lvii. p. 563) of an article upon photographic surveying, much progress has been made in the application of the methods of photography. Valuable information on the subject was given in a lengthy paper on the field-work of photographic surveying as applied in Canada, by Mr. A. O. Wheeler, of the Topographical Surveys staff of the Canadian Government, at the recent London meeting of the Institution of Mining Engineers. In Canada, he stated, the principal surveys upon which the method has been employed are (1) survey of the Rocky Mountains by Mr. J. J. McArthur and Mr. W. S. Drewry, (2) survey in connection with the establishment of the boundary line between Alaska and the Yukon district by Mr. W. F. King, (3) survey of the Alberta watershed for irrigation purposes, (4) surveys in the Yukon district, on the Columbia River and in the Kootenay mining district, and (5) a survey of the Crow's Nest coalfield. The scale upon which the Canadian surveys have been mapped is as follows:—Rocky Mountains survey, 1 to 20,000; Alberta watershed and Crow's Nest survey, 1 to 30,000; Alaska surveys, 1 to 80,000. The larger the scale the greater is the detail required for the drawing. The office work occupies at least twice the time of the field work. To offset this the field work can be accomplished in half the time required for any other method. In the discussion that followed the reading of the paper, Mr. Bennett H. Brough gave particulars of the application of photographic methods to the survey of mining properties in the Carrara marble district, in Mexico and in the Styrian iron ore fields. The rapidity with which the field work was carried out was, he pointed out, a conspicuous advantage in unhealthy malarious districts which a mine surveyor was often called upon to survey.

SINCE the trials of H.M.S. *Viper*, when the wonderful speed of thirty-seven knots per hour was attained, until quite recently further data have not come to hand; but (says *Engineering Magazine* for May) a vessel is now under construction at Dumbarton (Messrs. W. Denny and Bros.) 250 ft. long, 30 ft. beam, and 17 ft. 9 in. depth, which will be propelled by Mr. Parsons' marine turbines, and will be arranged as follows:—There will be three (for going ahead) turbines, each on its own shaft, the high pressure turbine will drive the centre shaft and the two low pressure turbines the two outer shafts. The two "astern" turbines (which propel the ship backwards) are placed inside the exhaust ends of the two low pressure turbines. By this arrangement in going "ahead" steam is expanded five times in the high pressure turbine and again twenty-five times in the two low pressure turbines, giving a total expansion of "125-fold" instead of about "16-fold" which is obtained with triple expansion reciprocating engines. The vessel under construction is for passenger traffic, which necessitates a regular high speed, and there is no doubt that with a ship of this class the best and the most useful results will follow, and not only will she be the pioneer of Mr. Parsons' marine compound turbine in the mercantile marine, but also she will embody all the advantages claimed over ships driven with reciprocating engines, which may be summed up as follows:—(1) Increased speed for the same boiler-power; (2) absence of vibration; (3) increased cabin accommodation (due to the smaller space required for machinery); (4) less upkeep in machinery and smaller engine-room staff. Time alone will prove the increased speed of this vessel and the validity of these advantages claimed over her commercial predecessors.

AN interesting description of the period of activity of Vesuvius in April and May of last year is given by Prof. R. V. Matteucci in the *Bollettino* of the Italian Seismological Society (vol. vi. No. 7), and one of the illustrations accompanying the paper is here reproduced. The eruption commenced on April 24, and lasted a month. There was no lava flow, but the explosions in the crater were very strong, and reached a maximum on May 9, when they were distinctly heard over almost the whole of Campania. The greatest height reached by the volcanic bombs and scoriæ was about 540 metres from the bottom of the crater,

An explosion of Vesuvius in May, 1900

and the largest block ejected had a volume of about twelve cubic metres and a weight of nearly thirty tons. The volume of material thrown out by the volcano during the months of April and May was estimated to have been about half a million cubic metres. For three days Prof. Matteucci remained near the crater of Vesuvius, and on one occasion was fortunate enough to witness an explosion which surrounded him with falling scoriæ and lapilli without injuring him, though the eruption destroyed his photographic apparatus. His observations upon the appearance of the crater during incandescence and the character of the volcanic products are of much interest.

AN aid to the scientific pursuit of photography is afforded by the "Chapman Jones Plate Tester" produced by Messrs. Sanger Shepherd and Co. This new photographic accessory consists essentially of a series of graduated transparencies, a colour sensitometer, and a series of colours—each including one definite region of the spectrum. All these are on one plate and are arranged to show at a glance (1) sensitiveness of ordinary plates, (2) the added sensitiveness of isochromatic plates, (3) the further added sensitiveness of red sensitive plates, this last, being in two parts, distinguishing between the more and the less refrangible than the Fraunhofer line C. The graduated series gives a quantitative value to the colour tests; without it a series of exposures would be necessary, and the result even then would be indefinite. By a single exposure and development the screen gives a quantitative expression of all the properties of photographic plates that are generally of use. Moreover, the record thus obtained can be preserved for more critical examination at any future time, when exact measurement with a photometric arrangement or opacity meter will give results probably as accurate as could be obtained by any method of testing. A plate tester having these joint merits of simplicity and accuracy should prove of service to photographers who base their art upon scientific principles.

"PROSPECTING for Gold in County Wicklow" is the title of a paper by Mr. E. St. John Lyburn in the *Proceedings* of the Royal Dublin Society (vol. ix. new ser. part 4, 1901). The author gives the results of numerous assays of samples of quartz, grit, &c., and in one instance records 4 dwts. per ton from a specimen obtained near the summit of Croghan Kinshelagh. The owner of the estate unfortunately objected to prospecting and Mr. Lyburn had to abandon his work without settling whether or not Wicklow contains gold in payable quantity in the rocks. He observes that panning for gold is secretly carried on in the county and is apparently lucrative to those interested; and he urges further researches on Croghan Kinshelagh mountain, more especially at the junction of the diorite rocks and the Silurian formation.

THE Jurassic Brachiopoda of Cutch form the subject of an important monograph by Dr. F. L. Kitchin (*Mem. Geol. Surv. India*, ser. ix. vol. iii. part 1, 1900). The task undertaken by the author was one not unattended by difficulties, as many years have elapsed since the fossils were collected, and their geological horizons were not in all cases satisfactorily determined. He has, however, received much aid in deciding these matters from Prof. J. F. Blake, who not very long ago personally studied the region. A superficial glance at the plates would lead one to suppose that many British species of Inferior Oolite and Great Oolite Brachiopoda were represented, such as *Terebratula Phillipsi*, *T. globata*, *T. maxillata*, &c.; but although there are forms which appear to show affinity to British species belonging to different Jurassic divisions, yet such forms occur together in Cutch strata, and correlation becomes impossible when the forms on one horizon suggest Bajocian, Bathonian and Callovian ages. Most of the specimens now figured by Dr. Kitchin receive new names, even where the resemblance to a European form is great. This has been done in the belief that the application of the term "variety" is not admissible in cases where the direct relationship to the "species" either cannot be definitely proved or does not appear highly probable. It is satisfactory to learn with regard to Brachiopoda "that to a certain degree, the larger the number of individuals with which we have to deal, the fewer 'species' shall we find them to represent." It would have been better if the author had had the benefit of a series of specimens from a more clearly established stratigraphical sequence, but that he has made the best use he could of the material will not be questioned, and his illustrations are excellent. The fauna as a whole has a distinct facies and is without precise parallel in the European area.

THE Annual Report of the Royal Alfred Observatory, Mauritius, for 1899 has been issued. The chief meteorological feature of the year was the abnormal distribution of rainfall with regard to seasons. The greatest defects occurred in January and December, and the greatest excess in September. The mean rainfall at sixty-eight stations was 76·80 inches, the average amount being 79·23 inches. In possible connection with this we may mention that the deaths from plague were considerable in the months of October to December, following (as in Bombay) the coldest season and an exceptionally wet winter. The report is entirely satisfactory in all respects save one—for want of proper provision for the library, many valuable works are destroyed by rats and other vermin. The director is naturally seriously concerned at this unsatisfactory state of things.

CONSTANTLY increasing attention is being paid to practical entomology in the United States, and we have just received two new parts of the *Bulletin* of the New York State Museum, both of which relate primarily to agricultural entomology. No. 36, vol. vii. (March 1901) contains the sixteenth Report of the State Entomologist on injurious and other insects of the State of New York; and No. 37, vol. viii. (September 1900) contains an illustrative descriptive catalogue of some of the more important injurious and beneficial insects of New York State. These are both by Dr. Ephraim Porter Felt, State Entomologist, and are similar in character to other American Reports which we have recently noticed. We may call attention to two special points in these. The State of Massachusetts seems to be relaxing its campaign against the gipsy moth in despair, and its spread to other States is greatly dreaded. After all the nonsense written in the popular papers about the "kissing bug," it is amusing to find that, according to Dr. Felt, it is neither more nor less than our own wheel bug, *Opsicoetus* (or *Reduvius*) *personatus*, which is common in Europe in outhouses, &c.

THE *Bulletin* of the American Museum of Natural History for 1900 (vol. xiii.) contains an unusual amount of matter interesting to the student of vertebrates, both living and fossil. Some of these papers, such as Prof. Osborn's studies of the European and American fossil rhinoceroses, have been already noticed in these columns, owing to the fact of separate copies having been received. The volume opens with an account, by Dr. J. A. Allen, of the caribou, or reindeer, recently described by Mr. Seton-Thompson under the name of *Rangifer montanus*. The author confirms the distinctness of this form, which is from British Columbia and the North-west Territories, and compares it with other American reindeer, giving a number of excellent photographs of antlers.

IN another communication Dr. Allen gives some interesting notes on the so-called wood-bison of the neighbourhood of the Great Slave Lake, which he considers to be rightly regarded as a distinct race of the species, although it probably once intergraded with the typical bison of the plains. Mr. F. Russell, who hunted these animals in 1894, informed the author that the herd at that time comprised only a few hundred head. "They cannot be hunted in summer," he writes, "as the country which they inhabit is an impenetrable mosquito-infested wooded swamp at that season. . . . They can only be killed by stalking in mid-winter, when their pelage is at its best." This is so far satisfactory, and affords some hope for the survival of the herd, which the Canadian Government is endeavouring to protect. Additional notes on both the reindeer and the bison of the North-western Territories and neighbouring districts are communicated by Mr. A. J. Stone in his report of a collecting trip.

PALÆONTOLOGISTS will find much matter for study in two articles communicated to the aforesaid *Bulletin* by Mr. R. P. Whitfield, the one dealing with certain Arctic fossils collected by the Peary expedition, and the other with the type-specimens of the marine cretaceous lizard described by Cope as *Mosasaurus maximus*. It is inferred that this monster could not have been less than eighty feet in length; portions of the jaws are figured for the first time. Monmouth county, New Jersey, is their place of origin. The Arctic fossils are of Silurian age, and differ in some cases specifically from their representatives in the New York district. In regard to some of the corals, the author writes as follows:—"The specimens are from calcareous clay and are finely weathered, indicating a locality where fine collections of fossils might be obtained with little trouble. The specimens have been collected from the surface and are mostly of small size and imperfect, so much so that those representing undescribed forms are too poor for description and illustration, though sufficient to determine the geological position.

ACCORDING to its Report for the past year, the Zoological Society of Philadelphia has started a new departure in regard to membership which may be commended to the attention of similar bodies at home. This is the admission of junior members, who pay an annual subscription of one pound (five dollars) up to the age of eighteen, when they are eligible for the full membership. In reporting the construction of a new aviary in the gardens, the directors call attention to the reduction which has been found advisable in the size of the cages. This reduction "has resulted from the long experience of the Society in the effort to adjust the needs of animal life to the economical limitations which are forced upon most zoological collections formed upon a large scale. In many groups, as in parrots among birds, and in reptiles of sluggish habit, it has not been found that cages relatively extravagant, both in space and cost, have added observably to health or longevity; in fact, with parrots the best results have been reached in cages too small to induce the attempt to fly." It is added that the public are gainers by the new plan.

WE have received a copy of the *British Central Africa Gazette*, with a supplement containing a full reprint of meteorological observations taken thrice daily at Zomba, during February, 1901. The organisation under which these observations are made is under the direction of Mr. J. McClounie, head of the Scientific Department, and its inauguration has been largely due to the efforts of the British Association Committee on the climate of tropical Africa.

IN the April number of the *Zeitschrift für physikalische Chemie* is a paper by G. Bredig and K. Ikeda, continuing the work commenced by G. Bredig and M. v. Berneck on the "inorganic ferments." It was shown in the first paper that there is a remarkable analogy between the behaviour of a solution of colloidal platinum and the organic enzymes, especially those present in blood. The platinum solution, on account of its perfectly definite composition, lends itself readily to quantitative study, and the results of a very numerous set of determinations of its catalytic power in decomposing solutions of hydrogen peroxide are given. The most remarkable analogy worked out in the second paper is that just as minute traces of certain substances inhibit the catalytic action of the enzymes of the blood, so traces of the same or similar substances act as "poisons" to the colloidal platinum, the quantities necessary in some cases being extraordinarily small. Thus the strongest blood poison is hydrocyanic acid, and this is also the strongest "poison" for colloidal platinum; thus the presence of only 0·0014 milligram of prussic acid per litre was sufficient to reduce the activity of a certain platinum to one-half its original value. Other blood poisons, such as iodide of cyanogen, mercuric chloride, phosphorus and carbon monoxide, behave similarly towards the platinum solutions. There is no doubt that this work will lead to more quantitative studies of the catalytic action of the enzymes proper, the importance of which in both animal and plant physiology is becoming every day more manifest.

SOME of the papers published in the reports and other volumes of the Smithsonian Institution are printed separately for sale or exchange. A classified list of the papers at present available has been issued, and students of all branches of science will find in it many publications of value.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mrs. W. W. Baker; a Red-flanked Duiker (*Cephalophus rufilatus*, ♂) from West Africa, presented by Mr. Th. Leportier; two Crested Curassows (*Crax alector*) from Guiana, presented by Mr. Robert Thom; two Vulturine Eagles (*Aquila verreauxi*) from the Gwatyn District, Cape Colony, presented by Mrs. Joplin; a Derbian Zonure (*Zonurus giganteus*) from South Africa, presented by Mr. W. Champion; a Blue and Yellow Macaw (*Ara ararauna*), a Brazilian Tortoise (*Testudo tabulata*) from South America, a Red-masked Conure (*Conurus rubrolarvatus*) from Ecuador, a Starred Tortoise (*Testudo elegans*) from India, two American Glass Snakes (*Ophiosaurus ventralis*) from Mexico, seven Stink-pot Mud Terrapins (*Cinosternum odoratum*), twelve Pennsylvanian Mud Terrapins (*Cinosternum pennsylvanicum*) from North America, deposited; three Mandarin Ducks (*Æx galericulata*) from China, purchased; a Thar (*Hemitragus jemlaica*, ♂), a White Stork (*Ciconia alba*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE RECENT TOTAL ECLIPSE OF THE SUN.—From the *Comptes rendus* we learn that a French expedition under M. Binot made successful observations at the island of Réunion, near Mauritius, so that very valuable comparisons may be hoped for between these and the photographs obtained at the Royal Alfred Observatory further east.

A telegram from Pulkowa states that during the eclipse at Padang, six photographs were obtained through cirrus clouds, the form of the corona corresponding to that of minimum solar activity.

SNOW ON THE MOON'S SURFACE.—Several accounts have appeared in the daily Press stating that observers from the Harvard College Observatory working in Jamaica have obtained photographs of the moon which afford evidence of the existence of some variable substance, probably snow, on many of the mountain peaks. The astronomer, presumably Prof. W. H. Pickering, has taken photographs of the lunar disc under as varied conditions of lighting as possible during several nights, and the inference now drawn depends on the interpretation of the changes in appearance of the highest tips of the lunar craters. Up to the time of writing no direct confirmation of these observations has been received in this country.

OXFORD UNIVERSITY OBSERVATORY.—The twenty-sixth annual report of the Savilian professor of astronomy to the board of visitors contains an account of the work of the observatory from 1900 May 1 to 1901 April 30. Prof. Turner states that the staple work during the year has been the measurement and reduction of the plates for the Astrographic Catalogue. This has been partly hindered by the building of the new dome and the arrangements for observing the minor planet Eros during its recent opposition, and also the Nova Persei. However, seventy-eight plates have been completed during the year, making a total of 783 in five years, out of the 1180 required. For the Eros determinations 114 plates were obtained, involving 757 different exposures, about half of these having been measured.

The instruments used in India (1898) and Algiers (1900) were taken to Sumatra by Mr. Newall, who will endeavour to make similar determinations with them of the brightness and polarisation of the corona, so that data on a uniform scale from all three coronas may be available for measurement.

All the instruments are in fairly good working order; the new dome by Messrs. Cooke and Sons gives every satisfaction.

THE ROYAL OBSERVATORY, GREENWICH.

ON Saturday last the Astronomer Royal presented his report for the past year to the Board of Visitors of the Royal Observatory. The weather was not all that could be desired on such an occasion, but the rain, which fell later in the afternoon was not sufficiently heavy to mar the proceedings.

Among the numerous guests were M. and Madame Lœwy from Paris.

Below will be found a brief *résumé* of the report:—

Transit Circle.

The sun, moon, planets and fundamental stars have been regularly observed on the meridian as in previous years. The number of transits, the separate limbs being counted as one observation, amounts to 10,938.

The number of stars observed in 1900 is 4787.

The apparent correction for discordance between the nadir observations and stars observed by reflexion for 1900 was found to be $-0''.39$. The results of recent years are as follows:—

	Mean.	Range in Yearly Means.
1880–1885	$-0''.34$	From $-0''.29$ to $-0''.45$
1886–1891	$+0.03$	,, -0.12 to $+0.09$
1892–1900	-0.30	,, -0.25 to -0.41

The New Altazimuth.

This instrument is in good working order, and the new chronograph has worked satisfactorily. Some inconvenience has, however, been caused by breakages in the system of spider lines, which has a larger span than is really necessary.

The instrument has been used during the year mainly as a reversible transit-circle in the meridian in four positions for the better investigation of systematic errors, and for observation of the Eros reference stars and fundamental stars.

Throughout the year 6937 observations have been made, including those for the determination of the chief instrumental errors.

The 28-inch refractor has been used throughout the year for micrometric measurements of double stars.

With the 26-inch Thompson equatorial, the most important work has been the photographing of the planet Eros during the recent opposition for determination of the solar parallax. 255 photographs have been obtained, 197 of which show the planet satisfactorily.

Astrographic Equatorial.

Up to May 10, 682 plates have been taken on 167 nights; 72 of these, for various reasons, have, however, been rejected. In addition to the plates for the chart, 7 photographs were secured for the adjustment of the instrument, two of standard areas, 294 of Eros, 139 of Nova Persei, and 3 of Comet *b* 1900.

The report states that 144 chart plates have been copied on glass, and during the year 81,000 measures of pairs of images (6m. and 3m.), as well as of the diameters of the 6m. images, have been made. The number of plates measured in the twelve months in two positions of the plates is 137.

The measurement of the plates is now completed for 1412 square degrees out of 2087 (which is the area of the Greenwich zone), so that two-thirds of the whole work of measurement has now been done.

Spectroscopic and Heliographic Observations.

With the Thompson equatorial and the photographic spectroscope mounted on it, 22 photographs of the spectra of Capella, Regulus, Arcturus, Spica, α and μ Ursæ Majoris with comparison spectra have been obtained, and some preliminary measures of these give satisfactory results. The spectroscope is now in good adjustment.

For the year 1900, Greenwich photographs have been selected for measurement on 146 days, and photographs from India and Mauritius (filling up gaps in the series) on 214 days, making a total of 360 days out of 365 on which photographs are at present available. The decline in the number of spots noticed in the last report has been continued, and the minimum may be considered as reached, no Greenwich photograph showing a spot since March 7.

Magnetic Observations.

The variations of magnetic declination, horizontal force and vertical force, and of earth currents, have been registered photographically, and accompanying eye observations of absolute declination, horizontal force and dip have been made as in former years.

The regular determinations of magnetic declination, horizontal force and dip have been made with the new declinometer, the Gibson deflexion instrument, and the Airy dip circle mounted in the new Magnetic Pavilion.

The principal results for the magnetic elements for 1900 are as follow:—

Mean declination	16° 29'·0 West.
Mean horizontal force	4·0014 (in British units). 1·8450 (in Metric units).
Mean dip (with 3-inch needles) ...	67° 8' 27".

These results depend on observations made in the new Magnetic Pavilion, and are free from any disturbing effect of iron.

The magnetic disturbances in 1900 have been few in number. There were no days of great magnetic disturbance and eight of lesser disturbance.

The question of the possible effect of disturbances from electric railways on the magnetic work carried on at the Royal Observatory has required very careful consideration in regard to the conditions under which electric traction may be used without injuriously affecting the magnetic registers.

It may be remarked that the French magnetic observatory at St. Maur is in much the same position as Greenwich in respect to electric tramways, and recently M. Moureaux, in charge of that observatory, has found that copper "dampers" (such as have been in use at Greenwich for sixty years, but had not previously been applied to the magnets at St. Maur) reduce the vibratory disturbances from electric tramways to about one-tenth of their amount. This has recently been verified at Greenwich by the converse process of removing the copper "dampers" which are in regular use with the declination and horizontal force magnets, when it was found that the disturbances from existing electric railways were increased to about ten times their amount. It is proposed to apply a "damper" to the vertical force magnet, the need for which has not hitherto been felt, and it is possible that the "dampers" for the other two magnets may be improved by the use of copper of much higher conductivity than was obtainable when they were made sixty years ago.

It is hoped, however, that, in the event of future proposed electric tramways, regulations will be laid down by the Board of Trade to secure adequate protection for the magnetic work at Greenwich, which has now been carried on continuously on the same general system for a period of sixty years, and which could not be transferred to another site.

Meteorological Observations.

The meteorological instruments are all in good order. The registration of atmospheric pressure, temperature of the air, and of evaporation, pressure and velocity of the wind, rainfall, sunshine and atmospheric electricity has been continuously maintained.

The mean temperature for the year 1900 was 50°·5, being 1°·0 above the average for the fifty years 1841–90. During the twelve months ending 1901 April 30, the highest temperature in the shade (recorded on the open stand in the Magnetic Pavilion enclosure) was 94°·0 on July 16. The highest temperature recorded in the Stevenson screen in the enclosure was 91°·8, and in that in the Observatory Grounds 93°·4 on the same day. This is the highest shade temperature recorded in July since 1881. It has been twice exceeded in July in the sixty years 1841–1900, viz., on 1881 July 15, when the temperature reached 97°·1, and on 1868 July 22, when it was 96°·6. A reading of 94°·0 was also recorded on 1876 July 17. The monthly mean temperature for July was 66°·6; it has been exceeded only four times in the preceding sixty years, viz., in 1852, 67°·0; 1859, 68°·9; 1868, 68°·1; and 1876, 66°·7. The month of December was also exceptionally warm, the mean temperature for the month being 45°·7, which is 6°·0 in excess of the fifty years' average. This value has been exceeded three times in the preceding sixty years, viz., in 1852, 47°·6; in 1868, 46°·1; and in 1898, 45°·8. The lowest temperature of the air recorded in the year was 20°·4, on February 14. There were forty-seven days during the winter on which the temperature fell below 32°, a number slightly below the average.

The mean daily horizontal movement of the air in the twelve months ending 1901 April 30 was 298 miles, which is 17 miles above the average for the preceding thirty-three years. The greatest recorded daily movement was 973 miles on January 27, and the least 72 miles on December 23. The greatest recorded pressure of the wind was 34·4 lbs. on the square foot, and the greatest hourly velocity 54 miles, both on January 27.

The number of hours of bright sunshine recorded during the twelve months ending 1901 April 30, by the Campbell-Stokes instrument, was 1513 out of the 4457 hours during which the sun was above the horizon.

The rainfall for the year ending 1901 April 30 was 20·22 inches, being 4·32 inches less than the average of fifty years. The number of rainy days was 151. The rainfall has been less than the average in each year since 1894.

The remaining portion of the report deals with the work done in the remaining departments—namely, chronometer, time-signal, &c. It may be here remarked that arrangements have been made for a re-determination of the Greenwich-Paris longitude in conjunction with observers from the Paris Observatory, two of the four portable transit instruments used in former longitude work being available for the French observers, and the other two for the English.

It has been arranged with M. Lœwy that the first part of the longitude observations shall be made in October next, and the second part in the spring of 1902.

The eclipse of May 28, 1900, was observed by the Astronomer Royal with Mr. Dyson and Mr. Davidson in Portugal, while this year Mr. Dyson, with the assistance of Mr. Atkinson, went to Sumatra, and Mr. Maunder to Mauritius, for the recent eclipse of May 18.

In his general remarks the Astronomer Royal points out the great pressure of work that has fallen on all members of the staff during the past year. Two eclipse expeditions have been prepared and sent out, the revision of Groombridge's Catalogue for 1810, in connection with the Greenwich Second Ten-Year Catalogue (1890), the transfer of books and records to the New Observatory, and the rearrangement of the library and record rooms, all have added considerably to the ordinary work of the Observatory. Finally, he points out that within the last five months one-third of the whole staff of computers have left the Observatory for other posts and have had to be replaced by boys new to their work. Such an extensive change in the temporary staff has, to a certain extent, disorganised the work and has thrown a great strain on the assistants, who are charged with carrying it on under such difficult conditions. Considering the training and experience required in the varied work which, at Greenwich, has to be done by computers, a greater degree of permanence in the staff appears to be necessary for the continued efficiency of the Observatory.

THE MECHANICAL FORCES OF NATURE AND THEIR EXPLOITATION.

THE question of the probable end of the world's coal supply, in the not far distant future, is one which has in recent years been the cause of much discussion. In connection with this subject a pamphlet published by the Urania Gesellschaft of Berlin, on "Die mechanischen Naturkräfte und deren Verwertung," by F. Reuleaux, is of interest. In a clear and popular manner the author traces and explains the gradual utilisation by mankind of the various natural forces, from the ancient Assyrian water wheel to the installations of Niagara, and the Parsons steam turbine. It has been calculated that the supply of coal in England can only last at the most 200 years more; and though the coal-fields of the other European countries have not been used to the extent that the English ones have, still their eventual exhaustion can already be anticipated. The total consumption is now about 600 million tons per year, or, measured as a volume, about 500 million cubic yards. Assuming a yearly increase of 5 per cent. (it is at the present moment greater than this) this would mean that during the present century 6½ billion cubic yards of coal will be taken from the earth's coal mines. A cube of this volume would have a side over ten miles long.

It may be urged that this is not a matter of immediate importance; still, in considering the future industrial state of the world one must admit that great changes must take place, and that countries which have been indebted for their growth to their natural resources of power in the form of coal must give way to those countries where power is supplied in another form. On examining the natural sources of power, one sees that really the only other available source of power besides coal, which, it may be said, can be regarded as the accumulated energy of the sun, stored up through countless ages, is water power. This, unlike coal, is a source of energy which is always with us. The sun piles the waters of the ocean upon the mountain side, and following the force of gravity it flows down again in a never ending cycle, watering, fertilising and, under the careful direction of mankind, rendering the land fruitful and inhabitable and providing for the wants of the human race a source of power immeasurably greater than any power to be derived from the combustion of coal, and what is more, a source of power which will never cease, or be exhausted, while the world lasts. To form a computation of the total energy of the atmospheric depositions is very difficult. It has been calculated to reach the value of 100,000 million horse-power. The realisation of the one-thousandth part of this would be enough to replace the whole of the coal consumption for an incalculable time to come.

An example of how a water power can be used to its fullest extent is furnished by the Upper Hartz. There nearly every drop of water available is utilised, and, although boasting no streams of any size, the respectable total of 3300 horse-power is generated and used in the mining operations carried on there. It is, however, with the advent of electricity that the full realisation of water power has become possible. By means of the facilities offered us by this agent we arrive back at the original motive power of mankind, and will be enabled to tap energies incalculable in comparison with our present ones. This greatest and farthest-reaching application of electricity is but now in its infancy. In 1891, only ten years ago, the first long distance power transmission plant was erected at Lauffen on the Neckar. The power, amounting to 100 horse-power, was transmitted to the electro-technical exhibition at Frankfort on the Maine, a distance of 110 miles, at a voltage of 8000 volts, using a three-phase current. In the short space of time since then immense progress has been made. Now whole towns and large tracts of country are supplied with power and light from distant waterfalls, and new industries have sprung into existence which were formerly impossible. The future developments of this branch of science will be as great, comparatively, as the mighty forces of nature they are designed to employ, and in endeavouring to imagine them the scientific mind merges into the poetic, with which it is, after all, very closely related.

THE COLOUR AND POLARISATION OF BLUE SKY LIGHT.[1]

THE theory of the colour of the sky has been of slow growth. One of the first explanations that we find in scientific literature—almost barbarous in its crudity and unsupported by fact or theory—is the speculation of Leonardo da Vinci that the blue of the sky is due to the mixing of the white sunlight, reflected from the upper layers of the air, with the intense blackness of space. This corresponds to the speculative stage of science, the age of the philosophers. In the next step analogy comes into play; this is a most valuable and effective tool for the man of science endowed with a vivid scientific imagination and with a keen, clear insight into nature, but for others a most dangerous weapon. In this case it is wielded by no less an intellect than that of Sir Isaac Newton. In his optical investigations, about 1675, he had been led to a study of the colours produced when light is reflected from thin films of transparent substances; these he found to depend upon the thickness of the film. When it is very thin it appears black; as the thickness gradually increases it becomes blue, then white, yellow, red, &c. This blue which first appears, and which may be seen surrounding the black spot on soap bubbles, Newton termed the "blue of the first order," and he thought it was of the same tint as the blue of the sky. Analogy now steps in and suggests that the colour of the sky is due to the reflection of sunlight from transparent bodies of such a size that the reflected light is the blue of the first order. This was Newton's belief, and he thought that the reflecting particles were small drops of water.

This is the first theory worthy of serious consideration, and was for a time generally accepted as correct. But no theory based on pure analogy can be regarded as final; it must first be subjected to the most severe analytical and experimental criticism of which we are capable. If it stands the test, well and good; if not, it must be rejected. In 1847 Clausius subjected Newton's theory to a strict mathematical analysis, and proved that, if the blue of the sky is the blue of the first order, resulting from the reflection of light from transparent bodies, these bodies must be in the form of thin plates or thin-walled, hollow spheres. They cannot be solid drops or spheres, for then astronomical objects would never be sharply defined; a star would appear as large as the sun, and the sun immensely larger; all celestial objects would appear as large discs of light, brightest at the centre and fading out gradually toward the edges. For this reason Clausius, believing the blue to be that of the first order, held the opinion that the reflecting bodies were hollow spheres, or vesicles of water. The belief in the existence of so-called "vesicular vapour" did not originate with Clausius, but was a relic which had persisted from the speculative age to this time in spite of its *a priori* improbability, and the natural opposition so caused. As the theory of vesicular vapour has now been completely discarded we need say no more about it; the real value of the work of Clausius lies in the proof that the light from the sky cannot be due to the regular reflection of sunlight from small drops of water.

The experimental test was applied by Brücke, who pointed out that the blue of the sky is radically different from the blue of the first order. Thus, the era of analogy began to give way to that of experimentation and analysis, which must go hand in hand.

Brücke (1853) proved that the light scattered from a turbid medium is blue, and Tyndall (1869) performed his beautiful experiments on this subject, in which he showed that when the particles causing the turbidity are exceedingly fine (too small to be seen with a microscope) the scattered light is not only a magnificent blue but is polarised in the plane of scattering, the amount of polarisation is a maximum at an angle of 90° with the incident light, and the definition of objects seen through it is unimpaired by the turbidity. Here, for the first time, all the essential features of sky light were reproduced in the physical laboratory. This experiment of Tyndall's was at once recognised as giving the key to the problem. Lord Rayleigh (1871–1899) undertook the analytical treatment of the subject and proved that when white light is transmitted through a cloud of particles, small in comparison with the cube of the shortest wave-length present in the incident light, the light scattered laterally is polarised in the plane of scattering, the maximum of polarisation is at 90° to the incident light, and the intensities of the components of the scattered light vary inversely as the fourth powers of their wave-lengths; no account is taken of the light which has undergone more than a single scattering. All these facts have been shown to agree with the phenomena observed in the laboratory when light is passed through turbid media. Recently (1899) Lord Rayleigh has shown that in this way about one-third of the total intensity of the light from the sky may be accounted for by the scattering produced by the molecules of oxygen and nitrogen in the air, entirely independent of the presence of dust, aqueous vapour, or other foreign matter.

We cannot do better than to stop here for a few moments to consider Lord Rayleigh's physical explanation of the scattering produced by small particles. On this theory, light is propagated as transverse vibrations of the atoms or corpuscles of a medium that acts like an elastic solid; it is something like the waves that go along a rope when one end is shaken, only in the case of light we are dealing with no rope but with an infinite medium. When we speak of a beam of light being polarised we mean that all the vibrations in this beam take place in the same plane, and the plane of polarisation may be defined as the plane passing through the direction of propagation of the light but perpendicularly to the direction of the vibrations, and therefore perpendicular to the plane of vibration. Now, imagine a beam of parallel light advancing through a homogeneous medium, say the free ether, in a vertical direction; there will be no light propagated except in this direction; there will be no scattered light. If, however, there exist in it particles optically denser than the ether, but small as compared with the wave-length of light, then light will be scattered laterally by these. Indeed, the effect of these particles is to locally increase the effective inertia of the ether, whereas the rigidity remains unaltered; therefore, when a wave advancing through the medium reaches one of these particles, the displacement of the medium at this point is less than it would be were the particle absent. If we should apply to each

[1] Abridged from an article by Dr. N. E. Dorsey, in the U.S. *Monthly Weather Review*, September 1900.

particle a suitable force (which of course must be in the direction of the displacement and proportional to the difference of the densities of the particle and of the ether) we could restore the amplitude to the value it would have were the particle absent; under these conditions everything would go on as though there were no particle in the ether, and consequently there would be no scattered light, *i.e.*, we should have neutralised the effect of the particle by the application of this force. Hence, on the other hand, we would have the same scattered light if the particle were absent, and we should apply to this portion of the ether this force reversed in direction, that is to say, each particle acts as a centre of a certain harmonic force acting upon the surrounding ether. Such a force will send out a plane polarised wave, whose intensity is symmetrical about the direction of the force as axis; it is zero in the direction of the force, and a maximum in the plane perpendicular to this direction.

The exact effect of such a force has been investigated analytically by Stokes and also by Lord Rayleigh. The displacement in the wave sent out by it is

$$\xi = \frac{F \sin \alpha}{4\pi b^2 D r} \cos \frac{2\pi}{\lambda}(bt - r)$$

if the force is $F \cos \frac{2\pi bt}{\lambda}$; where r is the distance from the centre of force to the point where the displacement is measured; α is the angle between the direction of the force and the line joining the point considered to the centre of force or the mean position of the disturbing particle; b is the velocity of light; D the density of the ether; λ the wave-length of the light sent out by the force; and π is the ratio 3.1416.

If the displacement in the incident wave is $A \cos \frac{2\pi bt}{\lambda}$, the force we must apply to the particle to restore the displacement to its natural value is

$$T(D' - D) A \left(\frac{2\pi b}{\lambda}\right)^2 \cos \frac{2\pi bt}{\lambda},$$

where D′ is the optical density of the particle and T is its volume; therefore,

$$\xi = A \frac{D' - D}{D} \frac{\pi T}{r\lambda^2} \sin \alpha \cos \frac{2\pi}{\lambda}(bt - r),$$

and the intensity of the scattered light is for each particle

$$A^2 \left(\frac{D' - D}{D}\right)^2 \frac{\pi^2 T^2}{r^2 \lambda^4} \sin^2 \alpha.$$

Since the particles are in motion the light scattered from different particles will have no definite phase relation; hence, to get the effect of a cloud of such particles we must add the intensities of the light sent out by each separate particle.

If the incident light is plane polarised, α will be a constant for any given direction from the incident beam, and the total intensity of the light scattered in this direction will be

$$A^2 \left(\frac{D' - D}{D}\right)^2 \frac{\pi^2 \sin^2 \alpha}{\lambda^4} \Sigma \frac{T^2}{r^2}.$$

If the incident light is unpolarised, the intensity of the light scattered at an angle β with the direction of the incident beam will be

$$A^2 \left(\frac{D' - D}{D}\right)^2 \frac{\pi^2 (1 + \cos^2 \beta)}{\lambda^4} \Sigma \frac{T^2}{r^2},$$

where $\Sigma \frac{T^2}{r^2}$ denotes the sum of $\frac{T^2}{r^2}$ for all the scattering particles in the line of vision. In none of this have we taken account of the light that has undergone more than a single scattering. If we denote the mean of the square of $\frac{T}{r}$ by $\frac{T_1^2}{r_1^2}$ and let N denote the number of particles in the line of vision, we can write the expression for the intensity of scattered light in the form

$$A^2 \left(\frac{D' - D}{D}\right)^2 \frac{\pi^2 (1 + \cos^2 \beta)}{\lambda^4} \frac{N T_1^2}{r_1^2}.$$

What are the assumptions we have made in this treatment? They are:

(1) Every scattering particle is so small that when a wave of length λ passes through the medium containing it the force is the same at every point of the particle, *i.e.*, each particle is small as compared with the cube of the shortest wave-length of the incident light.

(2) The particles are so far apart that their effect upon the velocity of light through the medium is negligible; *i.e.* the particles are far apart as compared with the longest wave-length with which we are dealing.

In his discussion of Lord Rayleigh's equations, Crova claims there is a third assumption, viz., that the number of particles in unit of volume must be sensibly the same for all sizes of particles. He says: "La formule $\frac{1}{\lambda^4}$ est basée sur l'hypothèse que le nombre N de corpuscules contenus dans l'unité de volume d'air est sensiblement le même pour toutes les dimensions de ceux-ci." Mascart is of the same opinion. This is evidently wrong. The expression

$$A^2 \left(\frac{D' - D}{D}\right)^2 \frac{\pi^2 T^2 \sin^2 \alpha}{r^2 \lambda^4}$$

applies to particles of *all* sizes, provided they are small in comparison with the cube of the shortest wave-length. The light from a cloud of such particles is merely the sum of the light from the individual particles; the relative number of particles of various sizes does not enter into the consideration at all; indeed, the composition of the light is entirely independent of all consideration of the number and size of the particles other than as specified in the two assumptions we have named. Particles of a size intermediate between these small ones and those larger ones that reflect light regularly produce effects as yet unknown, and are not amenable to this analysis.

From Lord Rayleigh's expression for the intensity of the scattered light we may conclude, if the manifold or multiply scattered light may be neglected:

(1) The scattered light is polarised in the plane of scattering and the amount of its polarisation is $\frac{1}{1 + \cos^2 \beta}$, being a maximum (completely polarised) when the direction of scattering is perpendicular to the direction of propagation of the incident light.

(2) The intensity of the scattered light varies $\frac{1}{\lambda^4}$ times the intensity of the incident light. Its colour or wave-length is independent of the direction of scattering.

(3) The maximum intensity of the scattered light is in a direction almost coincident with that of the incident light and in the opposite direction, and the minimum is in the plane perpendicular to this.

(4) The larger the particles (provided the assumptions above are fulfilled), the more intense is the scattered light.

As stated above, we know little, if anything, about the action of particles that are just too large for this treatment to apply, but in another of his papers Lord Rayleigh has solved to the next approximation (on the electro-magnetic theory) the special case of spherical particles, and finds that the light scattered should vary as the inverse eighth power of the wave-length. In the air there are surely some particles approximately fulfilling these conditions, and hence the sky should appear bluer than indicated by the simple theory we have just considered. But we have not yet bridged the gap between "very small" particles and those large enough to give regular reflection.

We have thus far neglected the multiply scattered light, but this increases in intensity as the square and higher powers of the number of particles per unit volume, while the once-scattered light increases as the first power only. Hence, for a cloud of particles the multiply scattered light may easily become appreciable. This again increases the proportion of the blue.

For all these reasons the colour of the light from the sky should be expressed by the sum of a series of terms of powers of the reciprocal of the wave-length; not by a single term, as is ordinarily attempted. Crova, endeavouring to express the intensity by a single term of the form $\frac{k}{\lambda^n}$, found values of n varying from 2 to 6 under different conditions, the average being about 4, as Lord Rayleigh and Captain Abney had found. But in no case could n be determined so as to give more than a fair agreement. As we have seen, values of n higher than 4 are to be expected; the lower ones are to be accounted for by the lateral scattering caused by the particles between the observer and the source of the scattered light which reaches him, by the absorption of the short waves by interposed water vapour and by the admixture of white light reflected from the larger particles.

The scattering to which we have been referring is evidently different from what we ordinarily mean by reflection; the latter assumes that the reflecting surfaces have an area large as compared with λ^2; whereas scattering assumes that the volume of the particle must be small as compared with λ^3.

Such is in outline the theory and the main facts in regard to the cause of blue sky light; but there are several secondary features which must be now considered. The sky is bluer in the zenith than elsewhere, evidently because the path traversed by the scattered light is here the shortest, so that it suffers less admixture with white light and less absorption of blue light. Conversely it should be less blue near the horizon, and when the sun is low may take on a red or orange tint, as we know is the case. The light from the zenith is most intense when the sun is nearest it, as at true noon, and its blue is least pure at the hottest part of the day, on account of the maximum amount of large particles of dust and vapour constituting the haze existing at this time.

Arago discovered that there is a point, about 15° above the point diametrically opposite the sun (the antisolar point), where the polarisation is zero; between this and the horizon the polarisation is horizontal. Babinet discovered a similar point above the sun, and Brewster found one below it. Between the neutral points discovered by Babinet and by Brewster the polarisation is horizontal; below Brewster's point and above Babinet's it is vertical. For a little way on each side of the neutral points the plane of polarisation is inclined at about 45° to the vertical. This seemed to indicate that superposed upon the polarisation resulting from the scattering of direct sunlight is a horizontal polarisation due to some secondary cause. It was soon suggested that the horizontal polarisation is due to a secondary scattering of the light coming from the lower layers of the atmosphere, and this has generally, but not universally, been accepted as the most probable explanation. Other neutral points have been observed under rare conditions.

The positions of the neutral points, the amount of polarisation, the position of the point of maximum polarisation, as well as the colour of the sky, are intimately connected with other meteorological phenomena, but as yet the observations have been so meagre, made under such dissimilar conditions and by such various forms of apparatus, that it is nearly impossible to tell what is the true connection.

Cornu says—in words of which the following is a translation—"In a general way, the amount of polarised sky light is connected in so direct a manner with the condition of the atmosphere that I have been led to think that it is characteristic of the state of the atmosphere. The greatest clearness of the sky corresponds to the greatest amount of polarisation; cirrus and fog decrease the amount, and even completely destroy the polarisation when the sky is overcast. . . . What is particularly interesting is that the least change in the state of the atmosphere is plainly shown by the polarimeter several hours before other precursory phenomena (barometric variation, halos and various other optical phenomena) have begun to indicate a change.

"Under these conditions it would be useful to carry out these observations in a methodical manner, and to compare the polarimetric variations with other elements characteristic of the atmospheric condition. . . . The amount of polarisation increases as the sun sinks below the horizon until it reaches a certain maximum, after which the polarisation rapidly disappears. The law of this increase of polarisation with the time is very important, for it appears to me to give the vertical distribution of fog in the atmosphere; indeed, if the increase is rapid the lower layers are foggy and the upper ones transparent; if the increase is slow, the atmosphere is more homogeneous."

In short, the more fog or cloud there is present the less the amount of polarisation and the less pure is the blue of the sky.

The most extensive series of observations are those of Rubenson and of Brewster on the polarisation, and of Crova and Abney on the colour of the light from the sky. The first limited himself to observations made in fairly clear weather, and the second directed his attention principally to the determination of the positions of the various neutral points. Rubenson and most other observers have laid special stress upon the intensity of the polarisation at its maximum point in the vertical circle through the sun. This is undoubtedly the point where observations can be most easily taken, and those so obtained must be of great meteorological value; but the interpretation of them is rendered difficult by the variation in the length of the path of the scattered light at different times of the day. At sunrise and sunset the point observed is the zenith, and the path is a minimum; while at noon, if the observer be in the tropics, the point observed may be on the horizon, and the length of the path a maximum. For other positions on the surface of the earth the variation in length of path is less than this.

On the other hand, unless we observe a point of maximum polarisation the observations will be vitiated by every error in determining the position, with respect to the sun, of the point observed. Though other objections may be urged, it has occurred to me that for meteorological prediction the most valuable data would be obtained from continuous observations of the amount of the polarisation of the light from points of the sky on the horizon and 90° distant from the sun. These are points of maximum polarisation; these observations will give a kind of integration of the atmospheric conditions over a large area, and the length of path being the same at all times the observations should all be comparable, except for the varying angle of illumination of the surface of the earth, which, unless the nature of the surface differs greatly in different directions, I think would hardly affect the results appreciably, except, perhaps, when the sun is near the horizon. No one, to my knowledge, has carried out such a series of observations, hence the suggestion is advanced with great hesitation.

Since the colour of the sky is independent of the angular distance of the point observed from the sun, being a function of only the state of the atmosphere and the thickness of the stratum observed, there is but little choice in the altitude of the point where we make the colour observations. But since the blue is a maximum in the zenith this is rather to be preferred, for a slight error in the position of the point observed will here produce the least effect.

Whatever point or points are observed, the fact remains that careful observations on the colour and the polarisation of the light from the sky will give us data determining the amount and size of the particles floating in the air, be they dust or water, and, as any change in the state of the atmosphere will affect these quantities, such observations should be of ever-increasing importance to meteorology. First, however, we must have a long series of observations taken at different places and under all conditions, with exact meteorological data obtained at the same time and place, together with a description of the nature of the surrounding country. When these have been obtained it should be not very difficult to find means of using future observations with great success.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Senate of the University of Dublin has decided to confer the honorary degree of D.Sc. upon Prof. W. Burnside, F.R.S., and Mr. W. E. Wilson, F.R.S.

ON Tuesday, June 18, Lord Avebury will open an exhibition of students' practical work, executed in connection with the technological examinations of the City and Guilds of London Institute, at the hall cf the University of London.

THE Report of the Council of the City and Guilds of London Institute upon the work of the Institute during last year refers to a number of noteworthy matters. The Institute has been incorporated by Royal Charter, but the general constitution remains unchanged. The Central Technical College has become a School in the Faculty of Engineering of the University of London. The Departmental Committee appointed to consider "the best means for coordinating the technological work of the Board of Education with that at present carried on by other educational organisations" has had several meetings, and it is hoped that arrangements may be made for the more intimate association of the work of the Institute's Technological Examinations Department with that of the Board, by which the overlapping of examinations may be avoided and the instruction provided by county councils and technical schools may be brought into closer relationship with the Board of Education and the Institute. Referring to the extrance examination and the teaching of science in secondary schools, the Council remarks: "The Central Technical College is the only college of the University in London which imposes such an entrance test for engineering, and unless and until the University is prepared to adapt its matriculation to suit the requirements of particular classes of students, which it is empowered to do under the new Statutes, and especially to engineering students, no very general or substantial improvement can be expected." Appended to the Report is an address given by Prof. Armstrong upon his retirement from the office of Dean of the College, his term having expired, and an address delivered by Sir Alexander R. Binnie at the opening of the current session. Both at the Central Technical College and at the Finsbury Technical College there was an increase in the number of students in the electrical departments, owing possibly to the development of electric traction in this country.

The president of the Massachusetts Institute of Technology, in his annual report, records that there were in the Institute at the end of last year no less than 1277 students—the largest number yet reached. Of this number 193 were fourth-year students. The average age on entrance is eighteen years and ten months, which is a few months more than the average age at which students enter the Central Technical College, London. An increasing number of students remain for a fifth year or enter the Institute for post-graduate courses. There are thirteen courses extending over four years, and including such subjects as chemical engineering, sanitary engineering and electrochemistry. In looking through the "Annual Catalogue" containing the outlines of the work done in these courses, we are reminded of the statement made in connection with the recent dismissals at the Royal Engineering College, Coopers Hill, that Indian engineers only need to know chemistry "to the extent required to enable the engineer to interpret results given by professional chemists." This is not the way in which engineers are trained at the best technical colleges in the United States, and if Lord George Hamilton and the Board of Visitors of Coopers Hill had seen the programmes of the engineering studies at the Massachusetts Institute they might have decided upon a more liberal action with regard to the subjects to be taught and the provision for teaching in a college where engineers are trained for the public service. The Faculty of the Massachusetts Institute has decided to discontinue the announcement of the degree of Doctor of Science, and to make the requirements for the degree of Doctor of Philosophy include "high attainments of a grade which qualifies the recipient as a scientific investigator and teacher." During 1900 the Institute received 100,000 dollars (less succession tax) under the will of the late Mr. R. C. Billings. The gift of 50,000 dollars by the late Mr. A. Lowell to constitute "The Teachers' Fund" has been increased to 100,000 by the executors, in conformity with his wishes. Other gifts received during the year amount to about 45,000 dollars. The total amount of the Institute property, both real and personal, was increased during the year by a net amount of 219,853 dollars, after deducting the sum of 8593 dollars, which is the excess of expenses over income.

SOCIETIES AND ACADEMIES.

London.

Royal Society, May 23.—"A Comparative Crystallographical Study of the Double Selenates of the Series $R_2M(SeO_4)_2,6H_2O$—Salts in which M is Magnesium." By A. E. Tutton, B.Sc., F.R.S.

This memoir on the magnesium group of double selenates, in which R is represented by potassium, rubidium and cæsium, is analogous to that which was presented to the Society in March 1900 concerning the zinc group.

The conclusions derived from the study of the morphological and physical properties of the crystals of the three salts are generally similar to those arrived at from the study of the zinc group. There is observed an uniform progression with regard to every property in accordance with the order of progression of the atomic weights of the three alkali metals present. That is to say, the constants of the rubidium salt are generally intermediate between those of the potassium and cæsium salts.

The magnesium group has, however, proved particularly interesting, inasmuch as the progressive diminution of double refraction, according to the rule which has now been established for this series of double sulphates and selenates, leads in the case of cæsium magnesium selenate to such close approximation of the three refractive indices that the crystals of this salt exhibit exceptional optical phenomena. This includes dispersion of the optic axes in crossed axial planes at the ordinary temperature, the uniaxial figure being produced for wave-length 466 in the blue; and the formation of the uniaxial figure for every wave-length of light in turn as the temperature is raised, the attainment of uniaxiality for red lithium light occurring at the temperature of 94°. As the life-history of the salt terminates at 100°, owing to the presence of water of crystallisation, this substance exhibits the property of simulating uniaxial properties at some temperature within its own life-range for every wave-length of light, while still retaining the general characters of monoclinic symmetry, including slight dispersion of the median lines. In this respect it resembles to a truly remarkable extent the analogous sulphate, which the author has shown to possess like peculiarities, but it is even more striking than the sulphate, as the dispersion is much larger. It is interesting to observe that these optical properties of cæsium magnesium selenate could have been predicted, given the constants of the potassium salt and the rules of progression established for the double sulphate and for the zinc group of double selenates. For the double selenates resemble the double sulphates so closely that in general it may be said that their properties are precisely parallel, the constants and curves being merely moved on to a slight extent by the replacement of sulphur by selenium without disturbing their relationships.

Physical Society, May 31.—Prof. S. P. Thompson, president, in the chair.—A paper on the resistance of dielectrics and the effect of an alternating electromotive force on the insulating properties of india-rubber, by A. W. Ashton, was read by Prof. Fleming. The author has obtained from his experiments formulæ for the charging and discharging currents of a condenser with rubber dielectric. The currents are exponential functions of the time. Curves for various potential differences have been plotted and were exhibited. These curves show that the insulating properties of rubber are increased by the application of high alternating electromotive forces.—Prof. Fleming then read a note by Mr. Ashton on the electrification of dielectrics by mechanical means. A sheet of pure Para rubber was placed in a condenser, the plates of which were connected to a quadrant electrometer. A two-pound weight was then dropped upon the condenser from a height of 3 inches. The electrometer received two impulses of opposite sign, one quickly following the other. The rubber was then stretched while in position and a potential difference of seven volts was shown between the plates, the top plate being negative. The condenser and electrometer were then discharged, the sheet reversed and the experiment repeated. The same effect was produced, the top plate again being negative. It appears, therefore, that polarisation of a dielectric being thus produced by mechanical energy, some part of the mechanical energy expended on the india-rubber during manufacture would remain in the dielectric as electric energy.—A model which imitates the behaviour of dielectrics, by Prof. Fleming and Mr. Ashton, was exhibited by Prof. Fleming. The behaviour of dielectrics with regard to their residual charge is analogous to that of wires subjected to mechanical stress. A simple twisted wire is not, however, able to imitate all dielectric effects, and the present paper describes a model which represents things more completely. Six pistons, separated by springs, are placed inside a vertical cylinder. The bottom piston fits fairly tightly in the cylinder. The second piston fits slacker than the first. The third piston has a small hole in it, and each succeeding piston has a greater area cut away, the top piston having just sufficient metal left to make the spring come to rest without vibration after being compressed. The cylinder is filled with machine oil and vaseline. To the top piston is attached a rod by means of which pressures can be exerted on the pistons for any length of time. This represents the charging of the condenser. The motion of the rod after releasing the weights represents the discharge of the condenser. This is registered graphically by a revolving drum, and the curves obtained are very similar to those from condensers with dielectrics. Prof. Ayrton said he would like to know in what respect the model shown was superior to a strained wire. He had noticed, about ten years ago, that alternating E.M.F.'s appeared to improve condensers. He was then working with comparatively small voltages, and he was interested to know that Mr. Ashton, working with high voltages, had established the improvement. The deflection obtained by stretching the india-rubber sheet might be due to changes in temperature, the dielectric having a high thermoelectric power. Mr. Price was glad that the question as to what actually might be called the resistance of a dielectric had been raised. There are two theories of residual charge, one due to Maxwell and the other to Heaviside. The model exhibited represents Maxwell's theory. He considered that the electrometer experiment with the rubber dielectric favoured Heaviside's theory—that is, that the dielectric is composed of small charged bodies similar to the small magnets conceived to constitute a magnet. He expressed his interest in the fact that the top plate of the condenser was always negative. Mr. Blakesley suggested putting a small hole in the bottom piston of the model so that it might represent a condenser passing a small steady current. With regard to the stretched rubber experiment, he said it would be interesting to make observations with the plates of the condenser vertical. Mr. Campbell said he had made experiments and found that the change in capacity of the rubber condenser affects the voltage sufficiently to mask the real effect. Mr. Appleyard said it was important to have perfect contact between the dielectric and the metal plates. It was pointed out by a visitor engaged in the cable industry that manufacturers are aware that pressure affects the insulating properties of guttapercha. Rubber is a mixture, and different rubbers behave differently under the action of alternating potential differences. The chairman said that if the quantity of electricity taken in on charging was equal to the quantity given out on discharge, then there could be no dielectric hysteresis.

Royal Microscopical Society, May 15.—Dr. R. Braithwaite, vice-president, in the chair.—A paper by Mr. Fortescue W. Millett, being part xi. of his report on the recent Foraminifera of the Malay Archipelago, was taken as read.—Notice was given that on June 19 there would be a special meeting of the fellows for the purpose of making certain alterations in the by-laws.—The secretary announced that at the next meeting of the Society there would be a paper on the aperture theory of the microscope by Mr. J. W. Gordon. Mr. Beck asked any fellows who possessed Abbe's diffraction apparatus to lend them for use in illustrating the subject of Mr. Gordon's paper. Mr. Gordon would endeavour to show that the effects described by Prof. Abbe, and relied upon by him to prove his diffraction theory, were produced, not by the object on the stage, but by the diaphragm over the object glass; to demonstrate this satisfactorily Mr. Gordon would require the use of several sets of diffraction apparatus besides those at his present disposal.—The chairman drew attention to a large number of objects illustrating pond life which were exhibited (under about 35 microscopes) by members of the Quekett Microscopical Club and fellows of the Society.

Zoological Society, May 21.—Dr. W. T. Blanford, F.R.S., vice-president, in the chair.—Mr. Oldfield Thomas read a paper on the more notable mammals lately obtained by Sir Harry Johnston in the Uganda Protectorate. The following species were described as new:—*Colobus ruwenzorii*, allied to *C. palliatus*, but with longer hair and less white on the tail-tip; *Genetta victoriae*, a genet nearly as large as a civet, strongly banded, and without a dorsal crest; *Procavia marmota*, like *P. dorsalis*, but much smaller; and *Cephalophus johnstoni*, like *C. weynsi*, but darker throughout.—A communication was read from Mr. R. C. Punnett containing an account of the Nemerteans collected by Prof. D'Arcy W. Thompson and others in Behring Straits, Davis Strait and North Greenland. Of the seven species enumerated in the paper two had been previously named, whilst the remaining five were new to science and were described as *Amphiporus arcticus*, *A. paulinus*, *A. thompsoni*, *Drepanophorus borealis*, and *Cerebratulus greenlandicus*.—A communication was read from Dr. W. B. Benham containing an account of the viscera of a whale of the genus Cogia. He pointed out that in this whale there is but a single blowhole asymmetrically placed like that of Physeter, but crescentic in outline, with the concavity directed backwards. The alimentary canal contained a dark-coloured substance, which the author considered to be the "ink" from the cuttle-fishes upon which this whale undoubtedly feeds, as was evidenced by the beaks of these molluscs in the stomach. The stomach was constructed upon the plan of that of the large sperm-whale (Physeter), and the author agreed with others in regarding the first division of it as a paunch belonging really to the œsophagus, and comparable with that of the Ruminants.—Mr. G. A. Boulenger, F.R.S., described two new species of chameleon, obtained by Sir Harry Johnston, K.C.B., on Mount Ruwenzori, under the names *Chamaeleon xenorhinus* and *C. johnstoni*.—A paper was read, prepared by the late Dr. John Anderson, F.R.S., shortly before his death. It contained an account of the reptiles and batrachians obtained by Mr. A. Blaney Percival in Southern Arabia. Twenty-five species of reptiles and three species of batrachians, of which specimens were contained in the collection, were enumerated; two of the former were described as new under the names *Bunopus spatalura* and *Agamodon arabicum*.—Mr. Boulenger described a new fish under the name *Gobius percivali*, specimens of which had been obtained by Mr. A. Blayney Percival in Southern Arabia.

Geological Society, May 22.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—On the skull of a chiru-like antelope from the ossiferous deposits of Hundes (Tibet), by Richard Lydekker. Twenty years ago the author proposed the provisional name of *Pantholops hundesiensis* for an extinct species of antelope typified by an imperfect skull figured in Royle's "Botany &c. of the Himalaya Mountains," pl. iii. fig. 1. The specimen is in the Museum of the Geological Society, and an examination has confirmed the original determination.—On the occurrence of silurian (?) rocks in Forfarshire and Kincardineshire along the eastern border of the Highlands, by George Barrow (Communicated by permission of the Director of H.M. Geological Survey). These rocks occur in three lenticular strips between the schistose rocks of the Highlands and the boundary-fault next the Old Red Sandstone. The largest is about twenty miles long, and extends almost from Cortachy to beyond the Clattering Bridge; it is about three-quarters of a mile wide at its widest. The rocks are divided into two groups, the Jasper and Green-Rock Series below and the younger Margie Series above. A section along the North Esk River is described in detail, and other sections referred to it. The lower division consists of fine-grained sandstones (bearing microcline), grey slaty shales, jaspers (sometimes containing circular bodies resembling radiolaria), and a variable series of basic igneous rocks ("green rock") of coarse texture and probably intrusive origin. The upper division consists of conglomerates, pebbly grits, dark and white shales, pebbly limestone and grey shale. The age of the series cannot be definitely ascertained, but the lower division is compared with the Arenig cherts, &c., of the Southern Uplands, while the Margie Series is newer than this, but older than the Old Red Sandstone.—On the crush-conglomerates of Argyllshire, by J. B. Hill, R.N. (Communicated by permission of the Director of H.M. Geological Survey.) While the sedimentary origin of the Highland Boulder-bed is proved by the foreign boulders contained in it, there occur in the Loch Awe region certain conglomerates, often along definite horizons, which may have been confused with it, but which the author is able to prove have originated by crushing. The sedimentary rocks of the area include all the members of the Loch Awe series, consisting of grits, slates and limestones, the latter being mostly gritty in character. Associated with these is an enormous amount of igneous material of Dalradian age, ranging from intermediate to basic in composition, together with porphyrite-dykes probably of Old Red Sandstone age, and a plexus of Tertiary dykes.

Linnean Society, May 2.—Prof. S. H. Vines, F.R.S., president, in the chair.—Prof. Charles Stewart, F.R.S., exhibited and made remarks on the egg and oviducal gland of *Scyllium catulus*, and on the nature of the egg-shell of Sphenodon.—Mr. W. P. Pycraft read a paper on the palate of the Neognathæ, in which he traced the derivation of the Neognathine from the more primitive Struthious or Palæognathine palate.—Mr. George Massee communicated a second instalment of his redescriptions of Berkeley's types of fungi, and explained the circumstances in which such redescriptions under higher powers of the microscope had become desirable.

May 24.—Anniversary meeting.—Prof. S. H. Vines, F.R.S., president, in the chair.

Anthropological Institute, May 28.—Prof. A. C. Haddon, F.R.S., in the chair.—Dr. Chervin referred to the proposed bibliography of anthropology and to the exchange of abstracts of *Proceedings*; he further suggested the possibility of a more frequent interchange of visits, offering, on behalf of his Society, to act as cicerone if the Institute would undertake an anthropological excursion in France.—Mr. A. Henry exhibited (1) an ancestral tablet, (2) a MS. of the Lolos of Yunnan.—Mr. J Gray presented a communication on the measurements of crania from the Fly River, New Guinea.—Mr. C. G. Seligmann presented anthropometrical craniological notes on the Eastern Papuans.—Dr. A. C. Haddon discussed the present state of our knowledge of the ethnology of British New Guinea.

CAMBRIDGE.

Philosophical Society, May 20.—Prof. Macalister, president, in the chair.—On the rate of growth of certain corals, by Mr. J. Stanley Gardiner. The author put in a plea for more precise observations on the subject, showing in discussing his specimens the various conditions of life, which he considered necessary to record. It was suggested that the volumes of specimens should be calculated, and that if possible the thickness of each skeleton, imagined as a flat plate covering the same horizontal area as its living colony, should form the basis for comparison. By the latter method the specimens showed, in a growth of less than 1030 days from the larvæ, various thicknesses between 10 and 25 mm.—On the breeding habits of *Xenopus laevis Daud*, by Mr. E. J. Bles.—On the recovery of foliage leaves from surgical injuries, by Mr. F. F. Blackman and Miss G. L. C. Matthaei. It has been found that if definite areas of these leaves be killed by heat or by physical means, the remaining sound tissues divide actively and form an absciss-layer which surrounds the dead cells and cuts out the area so that it drops away from the leaf. Specimens were exhibited showing the stages of this process, which takes place with such precision that leaves may thus be shaped to any desired form.—On a new species of *Bothriocephalus*, by Mr. A. E. Shipley.—On a class of matrices of infinite order and on the existence of matricial functions on a Riemann surface, by Dr. A. C. Dixon.—On liquid motion from a single source, by the Rev. H. J. Sharpe.

EDINBURGH.

Royal Society, May 20.—Prof. Geikie in the chair.—Mr. Alfred Harker communicated a paper on ice-erosion in the Cuillin Hills, Skye, in which evidence was accumulated to show that this region had never been over-ridden by foreign ice, but had supported during the maximum glaciation a local ice-cap. The general radial outflow followed with few exceptions the principal valleys, but on reaching the lower ground was sharply diverted toward the west by the pressure of the great Scottish ice-sheet. The chief part of the paper was devoted to an analysis of the surface relief of the Cuillins, the more striking elements of which were the result of glacial erosion, as distinguished from aqueous erosion. Among these were the general absence of any relation between detailed topography and geological structure; the unbroken extent of the main ridge with its steep flanks and cuspate cross-section, and the tricuspate ground-plan of its principal peaks; the curiously asymmetric form in cross-section of the branch ridges, with the steeper face always toward the north; the straight steep-sided valleys with U-shaped cross-section and abruptly stepped longitudinal profile; and other well-marked characteristics. The drift accumulations were also discussed, stress being laid on the action of ice not merely in grinding down a rock-surface but in tearing away fragments, especially of well-jointed rocks. The maximum glaciation in central Skye was succeeded by a period of valley glaciers; and at the same time the withdrawal of the Scottish ice-sheet allowed an unimpeded out-flow of the ice-drainage from the Skye mountains. At this stage the exposed summit ridges of the Cuillins suffered greatly from frost-action, the detached blocks being in part carried away on the glaciers, in part accumulating in great taluses wherever the head of a valley had become vacated by the dwindling ice.

PARIS.

Academy of Sciences, May 28.—M. Fouqué in the chair.—On the parallax of the sun, by M. Bouquet de la Grye.—The addition of hydrogen to various hydrocarbons, by MM. Paul Sabatier and J. B. Senderens. It has been shown in a previous paper that benzene and toluene in contact with hydrogen and reduced nickel readily form the hexahydro-addition products. It is now shown that this reaction is a general one, similar addition compounds being obtained from a great number of aromatic hydrocarbons. In the case of substituted benzenes in which the side chain exceeds a certain length, a secondary decomposition takes place. Thus ethyl-benzene gives not only the ethyl-cyclohexane, but also methyl-cyclohexane and a small quantity of methane. Propyl-benzene in the same way gives a little methyl-cyclohexane and ethyl-cyclohexane. The yields of the various hydrocarbons are very good, and the physical constants of several of them now prepared for the first time are given.—Observations of the comet A(1901) made at the Observatory of Algiers with the 31·8 cm. equatorial, by MM. Rambaud and Sy. The comet appears in the form of a nebula with a nucleus of a lustre comparable with a star of the 8th magnitude.—On the spectrum of the solar corona photographed at Elche (Spain) during the total eclipse of the sun of May 28, 1900, by M. A. de la Baume-Pluvinel. Five photographs of the corona and its spectrum accompany the paper.—The wave-length of some iron rays, by MM. Fabry and Perot. By the application of the interference method described by the authors in previous papers the wave-lengths of fifteen of the chief iron lines have been determined with an accuracy of six significant figures.—On the density of alloys, by M. E. van Aubel. The aluminium-antimony alloy containing 81 per cent. of aluminium is produced with a large increase of volume, 7 c.c. of aluminium and 12 c.c. of antimony giving 23·7 c.c. of the alloy AlSb.—On a very sensitive balance which is capable of acting either as a galvanometer, electrodynamometer or an absolute electrometer, by M. V. Cremieu. Two small magnets are carried on a small torsion balance composed of two silk fibres. These wires are sucked into bobbins carrying a current, the arrangement forming a sensitive astatic and dead beat galvanometer.—On the reduction of silver chloride by hydrogen, by M. Jouniaux. The interaction of hydrogen and silver chloride at various temperatures above 500° C. is reversible. The experimental results are applied to calculate the difference between the heats of formation of hydrogen and silver chlorides.—Observations on the preceding note, by M. Berthelot.—The action of mercuric oxide upon aqueous solutions of metallic salts, by M. A. Mailhe.

NEW SOUTH WALES.

Linnean Society, March 27.—Mr. J. H. Maiden, president, in the chair.—Description of a new species of Acacia, by J. H. Maiden. The plant described is an erect shrub of several feet from the highest part of the Blue Mountains.—Note on the Subgenus salinator of Hedley, by Edgar A. Smith.—Studies on Australian mollusca, part iv., by C. Hedley. Geological notes on Kosciusko, by Prof. T. W. Edgworth David, F.R.S, Richard Helms and E. F. Pittman. This paper deals with the subject of recent discoveries by the authors in company with Mr. F. B. Guthrie, of ancient moraines, erratics, and extensive rock surfaces grooved by glacier ice on the Kosciusko plateau. Some of the best preserved evidences noticed were in the Lake Albina Valley and in the valley of Lake Merewether (Blue Lake). At the latter locality there is a magnificent and well preserved moraine 400 feet above the surface of the lake, and containing ice-scratched blocks in enormous numbers. A very fine ice-grooved pavement of granite was observed at a point about 300 yards west of the southern end of Lake Albina. There is certain evidence that the glaciers came down, in comparatively recent geological time, to 5800 feet above the sea and probably to 5500 feet at least, Mount Kosciusko proper being about 7328 feet high. It is also clear that the ice in some of these glaciers was at least 400 feet thick. It is quite possible that at a still earlier period the whole plateau down to a level of about 5000 feet was buried under an ice-sheet. The exact downward limit has not yet been ascertained. The comparatively recent nature of the glaciation is shown by the fact that since the ice disappeared a depth of only about 10 feet of loose moraine and a further depth of 10 feet of soft slate have been eroded in the beds of the creeks which form the sources of the Snowy River. The authors consider that this evidence, taken in conjunction with that recently adduced in South America, Kerguelen, New Zealand and Tasmania, suggests a synchronism of glaciations of the northern and southern hemispheres, due to some such cosmic cause as that suggested by Dr. Arrhenius, viz., a slight temporary diminution of carbon dioxide in the earth's atmosphere.

April 24.—Mr. J. H. Maiden, president, in the chair.—Notes from the Botanic Gardens, Part 7, by J. H. Maiden and E. Betche. A number of new species and varieties were described.—Notes on the caves of Fiji, with especial reference to Lau, by B. Sawyer and E. C. Andrews. During their travels in the Fijian Archipelago the authors observed two types of caves—the excavated and the enclosed. Magnificent examples of caves excavated by percolation and subterranean streams occur in Viti Levu. In the Lau group appear the enclosed caves—vacant spaces walled and roofed in by coral growth. In their early stages these are seen in the living reef as precipitous chasms.—Observations on the eucalypts of New South Wales, Part 8, by Henry Deane and J. H. Maiden.—Bacteria and the disintegration of cement, by R. Greig Smith. Stutzer and Hartleb considered that the disintegration of the cement work of water reservoirs might be caused by the action of the nitrifying organisms. The author has investigated a case where the cement work of a water canal was disintegrating. Nitrifying organisms were found in the surface mud, but not deeper into the cement where disintegration was in active progress. The nitrifying bacteria appear when disintegration is complete. Other bacteria were separated by selective methods. One of these, *Bact. croceum*, can grow in bouillon with 5 per cent. sodium carbonate, but neither it nor the others separated had any action upon experimental cement blocks. Since the disintegrated cement contained alkali soluble in water equal to 1·4 per cent. lime, the disintegration is probably purely physical.—Notes on *Vibrio denitrificans*, Sewerin, by R. Greig Smith. This is not a vibrion, but an organism morphologically similar to *Rhizobium leguminosarum*. In media containing potassium phosphate, branching and irregular forms are found in young cultures. It appears to be a budding rod, and the variety of forms of the organism is caused by the mother and daughter cells being contained in a branching capsule.

CAPE TOWN.

South African Philosophical Society, April 24.—Mr. L. Péringuey, president, in the chair.—Mr. Garwood Alston showed three photographs of stones standing erect about six miles south of Port Nolloth, near which Mr. R. Colson found certain kitchen-middens, from which a skull and several native pots and grinding stones were obtained. The stones form enclosures of four feet by two, running north and south. Two of the enclosures were dug into, but yielded nothing. The underlying indurated sand seemed to be quite undisturbed. Mr. Alston emphasised the absence of evidence as to the meaning of the enclosures, and said that the small size was against the view that old burial places are indicated.—Prof. J. T. Morrison communicated a paper on some pressure and temperature results for the Great Plateau of South Africa, by Mr. J. R. Sutton. The author discusses the annual run of daily maximum and minimum temperatures, and of daily barometric pressures at Kimberley and Durban, as deduced from observations made during the ten years 1888–97, the pressures at Kimberley being, however, available only for 1890–97. The object was to discover the outstanding features of plateau meteorology. The results suggest to the author that "we might adopt the working theory (not forgetting how easy it is to theorise when facts are few), which, however, is rather a geometrical conception than a mechanical possibility, that there is a certain temperature factor—if we may so call it—travelling round the earth from west to east, while a pressure factor is going the opposite way."

DIARY OF SOCIETIES.

THURSDAY, JUNE 6.

ROYAL SOCIETY, at 4.—Election of Fellows.——At 4.30.—On the Electric Response of Inorganic Substances, Preliminary Notice: Prof. J. C. Bose.—On Skin-Currents. Part I. The Frog's Skin: Dr. Waller, F.R.S.—Vibrations of Rifle Barrels: A. Mallock.—The Measurement of Magnetic Hysteresis: G. F. C. Searle and T. G. Bedford.—A Conjugating Yeast: B. T. P. Barker.——Papers to be read *in title only*: Thermal Adjustment and Respiratory Exchange in Monotremes and Marsupials: a Study in the Development of Homo-thermism: Prof. C. J. Martin.—On the Elastic Equilibrium of Circular Cylinders under Certain Practical Systems of Load: L. N. G. Filon.—The Measurement of Ionic Velocities in Aqueous Solution, and the Existence of Complex Ions: B. D. Steele.

ROYAL INSTITUTION, at 3.—The Chemistry of Carbon: Prof. J. Dewar, F.R.S.

LINNEAN SOCIETY, at 8.—On the Necessity for a Provisional Nomenclature for those Forms of Life which cannot be at once arranged in a Natural System (Adjourned Discussion): H. M. Bernard.

CHEMICAL SOCIETY, at 8.—A Laboratory Method for the Preparation of Ethylene: G. S. Newth.—Oroxylin: W. A. H. Naylor and C. S. Dyer.—Some Relations between Physical Constants and Constitution in Benzenoid Amines, II.: P. Gordon and L. Limpach.—The Constitution of the Acids obtained from α-Dibromocamphor: A. Lapworth and W. H. Lenton.—The Decomposition of Chlorates. IV. The Supposed Mechanical Facilitation of the Decomposition of Potassium Chlorate: W. H. Sodeau.—Condensation of Phenols with Esters of the Acetylene Series. V. Homologues of Benzo-γ-pyrone: S. Ruhemann.—On the Action of Sodium Methoxide and its Homologues on Benzophenone Chloride and Benzal Chloride: J. E. Mackenzie.—Preliminary Note on Hydrides of Boron: W. Ramsay and H. S. Hatfield.—Gum Tragacanth: C. O'Sullivan.

RÖNTGEN SOCIETY, at 8.30.—X-Ray Diagnosis of Aneurism: Dr. Hugh Walsham.

FRIDAY, JUNE 7.

ROYAL INSTITUTION, at 9.—Mimetic Insects: Prof. Raphael Meldola, F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—The Geysers of the Yellowstone: John Parkinson.

SATURDAY, JUNE 8.

ROYAL INSTITUTION, at 3.—The Biological Characters of Epiphytic Plants: Prof. J. B. Farmer, F.R.S.

MONDAY, JUNE 10.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Travels in Search of Waves in 1900: Vaughan Cornish.

VICTORIA INSTITUTE, at 4.30.—Annual Meeting.—Address by Sir Robert Ball, F.R.S.

TUESDAY, JUNE 11.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Notes from Five Years' Work with X-Rays: W. Webster.

THURSDAY, JUNE 13.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: Prof. James Dewar, F.R.S.—The Nadir of Temperature and Allied Problems. (1) Physical Properties of Liquid and Solid Hydrogen: (2) Separation of Free Hydrogen and other Gases from Air; (3) Electric Resistance Thermometry at the Boiling Point of Hydrogen; (4) Experiments on the Liquefaction of Helium at the Melting Point of Hydrogen; (5) Pyro-Electricity, Phosphorescence, &c.

MATHEMATICAL SOCIETY, at 5.30.—Remarks on the Quartic Curve $2\alpha^3\beta + m\beta^3\gamma + n\gamma^3\alpha = 0$: A. B. Basset, F.R.S.—The Theory of Cauchy's Principal Values, II.: G. H. Hardy.—The Rational Solutions of the Equation $u^3 + v^3 + w^3 + p^3 = 0$: Prof. Steggall.

CONTENTS.

THURSDAY, JUNE 13, 1901.

HUXLEY.

Life and Letters of Thomas Henry Huxley, F.R.S. By Leonard Huxley. Vol. I., pp. viii + 503; Vol. II., pp. vi + 504. (London: Macmillan and Co., Ltd., 1900.) 30*s*. net.

THE real life of Huxley has still to be written. What is wanted is a critical study of the development of his striking personality and an estimate of the work of his life and the effect it has produced. I have nothing but praise for the two bulky volumes of the "Life and Letters," in which a filial duty has been accomplished with taste and judgment. But though they supply invaluable material they do not attempt to bring the facts of either career or performance to a clear focus.

Such a study in competent hands would be a fascinating undertaking. It would not merely give a picture of a very remarkable man, but would give also a chapter in the history of English science of supreme importance. I make no pretension to ability for the task myself, even if the columns of this Journal could afford the space. But I shall hazard the attempt to indicate the essential points which I should like to see more amply treated. I have gathered the material from a pretty close study of the "Life and Letters," and I have added the references of volume and page to quotations, which are not always easy to find, for any one who cares to verify them.

Nothing in tracing an eventful career is so attractive as speculation on the "might-have-been." It is probable, however, that within narrow limits "circumstance" counts for little beyond giving a dramatic touch to the story. But it played its part again and again in Huxley's life for what it was worth.

His family traces back to the north-west of England, where a certain fibrousness of character is commoner than in the south. His father was a master in Dr. Nicholson's school at Ealing, where Huxley was born in 1825. He describes himself as "a thread-paper of a boy" (ii. 35) with "a wild-cat element in me" (i. 5). For education in the ordinary sense:—

"I had two years of a pandemonium of a school (between 8 and 10), and after that neither help nor sympathy in any intellectual direction till I reached manhood" (ii. 145).

The school came to grief and Huxley's father moved to Coventry. Huxley was left to his own devices. What they were is almost incredible; but then he has told us that "*a priori* reasonings are mostly bosh" (ii. 212). At twelve he was sitting up in bed before dawn to read Hutton's "Geology" (i. 6). His great desire was to be a mechanical engineer; it ended in his devotion to "the mechanical engineering of living machines" (i. 7). His curiosity in this direction was nearly fatal; a *post mortem* he was taken to between thirteen and fourteen was followed by an illness which seems to have been the starting point of the ill-health which pursued him all through life. At fifteen he devoured Sir William Hamilton's "Logic." Twenty years later he says:—"From that time to this ontological speculation has been a folly with me" (i. 218). At seventeen he came under the influence of Carlyle. Nearly fifty years later he wrote:—

"There is nothing of permanent value (putting aside a few human affections), nothing that satisfies quiet reflection—except the sense of having worked according to one's capacity and light, to make things clear and get rid of cant and shams of all sorts. This was the lesson I learnt from Carlyle's books when I was a boy, and it has stuck by me all my life" (ii. 268).

At the same age he began his regular medical studies at Charing Cross Hospital with his brother, to whom Newman (afterwards Cardinal), who had been educated at the Ealing school (i. 19), gave a testimonial. He attended Lindley's lectures at the Chelsea Botanic Garden and won one of the medals of the Apothecaries Society. At the Medical School he studied under Wharton Jones, a physiologist who never seems to have attained the reputation he deserved. Perhaps he got mixed up with "the other fellow," who, Huxley thought, had "mistaken his vocation" (i. 94), an opinion in which, from personal experience, I can quite agree. Of Wharton Jones, Huxley says:—

"I do not know that I ever felt so much respect for a teacher before or since" (i. 21).

At twenty he went up for his First M.B. examination at the University of London, winning the gold medal for anatomy and physiology. Ransom, of Nottingham, won the Exhibition. Here circumstance came in.

"If Ransom had not overworked himself . . . . I should have obtained the Exhibition . . . . and should have forsaken science for practice" (ii. 133).

Would he?

Something had to be done to get a livelihood, and at the suggestion of a fellow student, now Sir Joseph Fayrer, he applied for an appointment in the Navy. Circumstance again, he came under Sir John Richardson, himself no mean naturalist, and through his influence was attached to the *Rattlesnake*. One of the oddest things about Huxley's career is the fact that almost every one he had to do with turned out sooner or later to be somebody notable. Through his Captain, Owen Stanley, "a thorough scientific enthusiast" (i. 25), he was introduced to Owen, Gray and Forbes, the first and last of whom had a good deal to say to his future career. The voyage of the *Rattlesnake* occupied four years. Huxley was twenty-five on his return. Few scientific men ever used their opportunities with keener sagacity. He spent no time in mere collecting. But, with an instinct which appears to me altogether extraordinary in one who was little more than a youth fresh from a medical school, he seized upon everything that was important and with regard to which new ground was to be broken; and, characteristically, he steadily kept their physiological interest to the front. The rest may be passed over rapidly; he had, in a scientific sense, his reward. His paper on the structure of the Medusæ had been published during his absence in the *Philosophical Transactions*. In this paper he laid down the fundamental character of the "ectoderm and endoderm." As Allman justly remarks, "this discovery stands at the very basis of a philosophic zoology" (i. 40). It is not too much to say that it is the foundation of modern zoological theory, and had Huxley never done anything else he would still have retained a classical place in its history.

At twenty-six he was elected a Fellow of the Royal Society. At twenty-seven he not merely received the Royal medal, but was placed on the Council. Certainly, half a century ago, our venerable Society showed no want of alacrity in recognising rising merit. And if any one wants to suggest that it has become less active in that respect he may be reminded that it was equally prompt in the case of Hertz.

It is certainly a notable circumstance that three men who were contemporaries and ultimately close friends, Darwin, Hooker and Huxley, each began his scientific career on board one of Her Majesty's ships. The consequence in each case was momentous to science: Darwin gave us the "Origin," Hooker a rational theory of geographical distribution, Huxley a reformed zoology. The odd thing is that while the two former returned confirmed naturalists the latter came back as impenitent as ever, and never was of a better mind till quite the end of his life.

At the age, then, of twenty-seven Huxley had placed himself with absolutely no aid in the very front rank of English scientific men. "What makes," he says, "the bigwigs so marvellously zealous on my behalf I know not. I have sought none of them and flattered none of them" (i. 78). Yet he did not emerge from the struggle altogether unscathed. Writing to Kingsley some eight years later he for once allows the cry of the wounded heart to escape him:—

"Kicked into the world, a boy without guide or training, or with worse than none, I confess to my shame that few men have drank deeper of all kinds of sin than I have" (i. 220).

Frankly, I do not believe a word of it. My experience of life does not lead me to think that any one who begins with a rank crop of weeds is very likely to ever reap a more substantial harvest. The plain fact is that the mood of confession is a perilous one, and from St. Augustine onwards most men who have yielded to it have found a sort of painful satisfaction in painting their past in the blackest colours. But I am entirely unable to find any point in Huxley's youth at which I can fix that outburst of the natural man. In a rather serious conversation I once had with him he spoke of a period in his life when he *might* have taken to evil courses; but he did not give me the smallest reason to suppose that in the retrospect he saw more than the existence of a possible *crevasse* in his path into which he might have fallen.

If Huxley's scientific reputation was established, his material position was still unassured. "Nothing," he says, "but what is absolutely practical will go down in England. A man of science may earn great distinction, but not bread" (i. 66). The struggle, however, in his case, if sharp, was less prolonged than it has been in the case of many other men. Owen got him his first temporary appointment (i. 95). Edward Forbes, "a regular brick"—an opinion I never heard any one gainsay—backed him "through thick and thin" (i. 107). He refrained, therefore, happily, from abandoning "all his special pursuits and take up chemistry, for practical purposes" (i. 86). He had tried to get "crystallised carbon" at fifteen (i. 10)!

Huxley was now thirty, and at last happily married. He might have succeeded Forbes in the Edinburgh chair, but "preferred to live in London on a bare sufficiency" (i. 120). He settled down at the School of Mines; his ship had come into port; what was the cargo he brought with him? As a boy he conceived a profound distrust of metaphysical speculation; at fifteen he writes in his note-book, hammered out from "Novalis," "Philosophy bakes no bread" (i. 9); that he stuck to to the end. From Carlyle he learnt his empiricism, a determination to see things as they are. From Wharton Jones he acquired an exact method, and from the *Rattlesnake* voyage confidence in his own powers of observation and courage to criticise the word of others. And here I must interpose the remark that it is difficult to estimate the services which biological science in this country owes to our medical schools. Up to the present time without them it would possibly not have existed amongst us at all. Huxley later on was more willing than I am to kick away the ladder:—

"Our side has been too apt to look upon medical schools as feeders for science. They have been so, but to their detriment as medical schools. And now that so many opportunities for purely scientific training are afforded, there is no reason that they should remain so" (ii. 310).

For my own part, owing much to medical training, I entirely dissent. The foundation of medical studies on a scientific basis, far from being detrimental, has in my opinion been of incalculable benefit to them. If Huxley really contemplated a division between medicine and science it was the worst cause he ever advocated.

Huxley's official duties, much against the grain, brought him face to face with palæontological problems. This not merely led to some of his most brilliant work, but put a weapon in his hand which he used afterwards with irresistible effect.

Half a century ago Owen was the dominant, and I think it must be admitted an evil, influence in the English biological world. He was saturated with the "naturphilosophie" and the teaching of Oken. Huxley was bound to come into collision with this. The Croonian Lecture in 1858, "On the theory of the vertebrate skull," demolished Oken's theory, and with it "fell the superstructure raised by its chief supporter, Owen, 'archetype' and all" (i. 141). Owen had already felt that his throne was tottering and, having borrowed the lecture-room in Jermyn Street for a course of lectures, boldly assumed, without the smallest warrant, the title of "Professor of Palæontology at the School of Mines" (i. 142). For this and many subsequent proceedings of a like nature the only plausible explanation that I can see is lunacy.

Here again Huxley laid one of the foundation stones of modern biological science. In his paper on the Medusæ he supplied the key which has unlocked the secrets of embryology; his Croonian lecture, followed by the work of Gegenbaur, has placed vertebrate morphology on a scientific basis.

This was his first conflict with scientific idealism, but it was a mere affair of outposts compared with the campaign that was to follow. He tells us :—

"I was not brought into serious contact with the 'species' question until after 1850. At that time I had long done with the Pentateuchal cosmogony . . . . from which it had cost me many a struggle to get free" (i. 167).

Later on he calls "the hypothesis of special creation . . . . a mere specious mark for our ignorance" (ii. 302). What was to be put in its place? Herbert Spencer, whose acquaintance he made in 1852, was unable to convert him to evolution (i. 168). He could not bring himself to acceptance of the theory—owing, no doubt, to his rooted dislike to *a priori* reasoning—without a mechanical conception of its mode of operation. Like Darwin, he derived no comfort from either Lamarck or the "Vestiges" (i. 168). For the former, nevertheless, he always entertained the most profound respect, and thought he would run Darwin "hard both in genius and fertility" (ii. 39). His review of the latter was the only one he ever had "qualms of conscience about on the grounds of needless savagery" (i. 168).

His attitude to evolution continued to remain altogether sceptical and stand-off. In his first interview with Darwin, which seems to have been about 1852, he expressed his belief "in the sharpness of the lines of demarcation between natural groups," and was received with a "humourous smile" (i. 169). Hooker, on the other hand, he thought "*capable de tout* in the way of advocating evolution" (i. 170); but then Hooker was in the secret.

Before continuing the story I think it will be helpful to state in simple terms the problem that Darwin attempted to solve, and to which he got his first clue in the Galapagos. Take a number of organisms at random and proceed to sort them according to their resemblances. When this has been done it will be found that they have fallen into groups larger or smaller, as the case may be. The members of the groups will closely agree in all essential particulars; they are *individuals*. Yet no two are exactly alike; this is *variation*. Yet within the group there will be nothing to oppose the view that each may pass into the other; the variation is *continuous*. This will not be the case in comparing groups themselves; the variation is more marked and *discontinuous*. The discontinuity can be expressed in technical terms, and these give us an abstract definition of the *species* or the distinctive marks common to the individuals forming the group. Treating species in the same way we arrive at a series of discontinuous groups of a higher order; these are *genera*. Continuing the process we obtain *families*. Proceeding onwards in the scale we find ourselves face to face with two, perhaps the most difficult of all to define—the Vegetable and Animal kingdoms.

Now Darwin, of course, saw with every one else that if the mode of origin of groups of the first order could be explained, all the rest followed. What was wanted was the discovery of some intelligible agency which could effect the passage of one organic form to another. As Huxley put it :—

"That which we were looking for, and could not find, was a hypothesis respecting the origin of known organic forms which assumed the operation of no causes but such as could be proved to be actually at work" (i. 170).

Darwin assumed continuous variation as an empirical fact and "natural selection" as the agency which had directed the course of organic evolution. This was a generalised form of the "artificial selection" which the cultivator and the breeder use every day in moulding organic nature pretty much as they will. As Huxley says :—

"My reflection when I first made myself master of the central idea of the "Origin" was, 'How extremely stupid not to have thought of that'" (i. 170).

Huxley's attitude to Darwinism deserves careful study. Some have thought that in his last public appearance at Oxford in 1894 he hinted his willingness to make a present of Darwin's theory to Lord Salisbury, as organic evolution could be established without it. And no doubt that is a view which can be maintained. Lord Salisbury had ridiculed the idea of the advantageous male in pursuit of the advantageous mate. This only showed that he could have studied Darwin to very little purpose. I am not one of those who think that the discontinuous "sport," advantageous or not, has played much part in evolution. But in any case its appropriate pairing is not essential, as it is now known that sports are frequently prepotent and their influence not easily swamped. The unmatched advantageous male is not so easily dismissed as Lord Salisbury seemed to think.

Huxley found in Darwin what he had failed to find in Lamarck, an intelligible hypothesis good enough as a working basis. But with the transparent candour which was characteristic of him he never to the end of his life concealed the fact that he thought it wanting in rigorous proof.

Now Darwin was a naturalist, and the "Origin" is emphatically the production of a naturalist. Huxley has repeatedly told us, what is perfectly true, that he was not one himself. "His love of nature had never run to collecting either plants or animals" (ii. 443). For him as for others Lyell "was the chief agent in smoothing the road to Darwin" (i. 168), for evolution is implied in uniformitarianism. Huxley was an anatomist, and the distinctions of the higher groups with which he chiefly occupied himself are anatomical. The discontinuity of those groups no longer troubled him now that he knew what lay behind Darwin's "humourous smile." But with "species" or primary groups he still found difficulties which I think he would not have found if he had had a naturalist's experience. At Edinburgh :—

"In common fairness he warned his audience of the one missing link in the chain of evidence—the fact that selective breeding has not yet produced species sterile to one another" (i. 193).

He states the point more precisely in a letter to Kingsley :—

"He (Darwin) has shown that selective breeding is a *vera causa* for morphological species; he has not yet shown that it is a *vera causa* for physiological species" (i. 239).

Now it seems to me that, to use one of his own favourite expressions, this is a shadow of the mind's own throwing. The species which Darwin undertook to account for are morphological. No other category conveys any meaning. There is a physiological difference between the sweet and bitter almond, because one is harmless and the other will kill; but it is unaccompanied by the smallest morphological distinction. Nägeli pointed out the importance of recognising this in bacteriology. What Huxley really meant by physiological species are species which are mutually sterile, and in this both he and Romanes seem to me to have rather begged the question.

Darwin, who was more aware of the weak points of his theory than any of his critics, took immense pains to show that sterility does not run parallel with taxonomic order. It is well known that it is *not* a criterion of species, as Huxley seemed to think—it does not seem to be even a criterion of genera. I can only suppose that some hint of Huxley's furnished the foundation of Romanes's heroic attempt to establish "physiological selection." If so, Huxley seems to have been little impressed with the result:—

"It (the 'Origin') is one of the hardest books to understand thoroughly that I know of, and I suppose that is the reason that even people like Romanes get so hopelessly wrong" (ii. 192).

But then Romanes was not a naturalist either.

Another difficulty was the principle that "*Natura non facit saltum*" (i. 176), and I think from the same cause. Bateson, of course, receives a benediction:—

"I always took the same view, much to Mr. Darwin's disgust" (ii. 372).

That "considerable 'saltus'" may occur is not improbable; but there can be little doubt that a species passes from one configuration to another, as Darwin supposed, by minute changes; and, as he has himself pointed out, we are not justified in assuming that the rate of variation has always been uniform.

Huxley, however, felt that he had at last a secure grip of evolution, and was soon on the war path; he warns Darwin:—

"I will stop at no point as long as clear reasoning will carry me further" (i. 172).

Nor did he. The history of "the great 'Sammy' fight" has often been told. It is interesting to know that it was Chambers, the author of the "Vestiges," who was responsible for it (i. 188). Its importance has been somewhat exaggerated. Evolution has made its way by a process of slow permeation. It has done so because, in the words of Helmholtz, it contains "an essentially new creative thought" (i. 364). But it was a brilliant dialectic victory for Huxley, and Oxford loves dialectic: "The black coats . . . offered their congratulations" (i. 189). "The Bishop . . . bore no malice, but was always courtesy itself" (i. 188). Huxley was, however, less forgiving, and put him in his pet little Inferno (ii. 341). Personally I entertain more than a sneaking admiration for him. He "cleaned up" the diocese of Oxford with a vigour worthy of Huxley himself.

One incident in the discussion is of some theoretical interest. The permanence or, as I prefer to say, stability of species seem to have been adduced as an argument against Darwin's theory. Lord Avebury:—

"instanced some wheat which was said to have come off an Egyptian mummy, and was sent to him to prove that wheat had not changed since the time of the Pharaohs, but which proved to be made of French chocolate" (i. 187).

But we have absolute evidence from tombs that Egyptian plants have not appreciably changed for 4000 years. And it is now known that the fact, instead of being an argument against, is rather one for the Darwinian theory.

Owen made a last desperate attempt to save the situation by asserting for man, on anatomical grounds, a completely isolated position in the animal kingdom. Huxley, in 1862, "showed that the differences between man and the higher apes were no greater than those between the higher and the lower apes" (i. 192). The case for the evolution theory was now complete.

Carlyle did not forgive the publication of "Man's Place in Nature," though it only carried the veracity of "Sartor Resartus" a step further. However, master and disciple both received together an honorary degree at Edinburgh, and I think there must have actually been some sort of reconciliation. For I have a distinct remembrance of hearing, I think from Huxley himself, that Carlyle expressed to him unbounded admiration for "Administrative Nihilism," coupling it with a by no means flattering estimate of another eminent philosopher.

Here I must leave Huxley's scientific work. He was now only thirty-seven. He found zoology in this country enchained in fantastic metaphysical conceptions; he extricated it almost single-handed. Writing to Leuckart in 1859 he says:

"Ten years ago I do not believe there were half-a-dozen of my countrymen who had the slightest comprehension of morphology. . . . I have done my best, both by precept and practice, to inaugurate better methods. . . . I confidently hope that a new epoch for zoology is dawning amongst us" (i. 163).

The hope has been amply realised. And if a quickening spirit has been breathed into every branch of biological teaching in this country, it was Huxley it came from. It is much to be wished that some one would record some recollections of the memorable courses of instruction at South Kensington which Huxley commenced in 1871, in which teachers and taught were alike inspired by an enthusiasm the tension of which almost reached breaking point, and in Huxley's own case, in fact, speedily did so.

Notwithstanding ill health his mental activity, constantly stimulated by a certain innate combativeness, kept him to the end immersed in public work of the most varied description and in the controversy that he loved. "Under the circumstances of the time," he says, "warfare has been my business and duty" (ii. 213). All this it is needless for me to touch upon. But no picture of Huxley would be complete which left out of sight the speculations which more and more absorbed him as his life drew to a close. In this Journal these can be only treated from a purely scientific point of view.

It is necessary to remember that Huxley's grasp of the principle of organic evolution was only arrived at by the process of reasoned and by no means hasty conviction. He satisfied himself that man could not be excluded from it. He was naturally therefore drawn to discuss human phenomena in relation to evolution.

The first was the problem of ethics. He summed up his conclusions in the Romanes lecture delivered at Oxford in 1893. This was his second speech delivered there; the first was in the "great Sammy fight," thirty-three years before. He might well say that "Oxford always represents English opinion in all its extremes" (ii. 441). He nearly succeeded in producing as much hubbub as on the first occasion. It is amusing, if not very edifying, to read the anxious preliminary negotiations. Huxley wrote, "Of course I will keep clear of theology" (ii. 350), and Romanes naturally writes back "in great alarm" (ii. 354). The pith of the whole thing was, "the cosmic order is not a moral order."

Morals are part of the cosmic order, but not identical with it. Seriously regarded, this is a very simple statement of pure fact, which is indeed the basis of one of Dr. Watts's most familiar "Sacred Songs," the orthodoxy of which no one has ever impeached. The order of nature is self-regarding, and, as that familiar writer implies, society "would be dissolved by a return to the state of simple warfare among individuals" (ii. 352). The contrary view, embodied in the phrase "ethics of evolution," Huxley traces to the ambiguity of the word "fittest." That "which survives in the struggle for existence may be, and often is, the ethically worst" (ii. 303).

"The actions we call sinful are part and parcel of the struggle for existence . . . and have become sins because man alone seeks a higher life in voluntary association" (ii. 282).

So far this is a utilitarian theory of morals, and, as far as it goes, accounts for the phenomena. But, as Huxley saw, it leaves unexplained the fact that probably every ethical system aims at a higher standard than is ordinarily reached or is perhaps even necessary in practice. This apparently he would explain by "an innate sense of moral beauty and ugliness (how originated need not be discussed)" (ii. 305). I confess I am sorry for that parenthesis. But the principle itself is comparable to Matthew Arnold's "Something not ourselves which makes for righteousness." At any rate, short work is to made of those who do not possess it.

"Some are moral cripples and idiots, and can be kept straight not even by punishment. For these people there is nothing but shutting up or extirpation" (ii. 306).

I hope it is not irreverent to say that "Injuns is pisin" seems to be a natural corollary. Huxley meant to look up Nietzsche (ii. 360), but probably never did. Had he done so the result would have been edifying.

A critical study of Huxley's theological views, especially in the light afforded by the "Life and Letters," would be extremely interesting. This is not the place to attempt anything of the sort. But some brief account is necessary. The starting point is to be found in a letter to Kingsley:—

"'Sartor Resartus' led me to know that a deep sense of religion was compatible with the entire absence of theology" (i. 220).

Now this suggests two remarks which are both justified, I think, by my own personal knowledge. In the first place I am firmly persuaded that he, if any one, was a deeply religious man. I am equally persuaded that he had a perfect passion for technical theology. He often thought himself, at least so he told me, that he might have been a successful lawyer. I do not doubt it. But the cerebral equipment which might have found employment in that direction got turned on to theology. This, I think, throws light on his shortcomings in this field. Dogma may be treated, and I think should be, in a scientific spirit; Huxley too often indicted it as if he were in a police court. There is no doubt that he adopted this attitude deliberately.

"My object has been to stir up my countrymen to think about these things; and the only use of controversy is that it appeals to their love of fighting and secures their attention" (ii. 291).

"I must," he says, "have a strong vein of Puritan blood in me somewhere" (ii. 91), and I think it cannot be doubted that he was right. His point of view was that of an extreme nonconformist. I need not say that this implies no disrespect, for nonconformity has been one of the roots of the English character.

In one aspect the religious sentiment is a response to the craving for a supernatural sanction to rules of conduct. Its varied but practically universal manifestation amongst mankind has got to be accounted for by evolution just as much as the possession of a vertebral column. It is not practically helpful to dismiss it as irrational.

Huxley, like others of a Puritan temperament, had more liking for the Old Testament than the New: "the only religion that appeals to me is prophetic Judaism" (ii. 339). But Calvinism, I think, contained much with which he most nearly sympathised. "Science," he wrote to Kingsley, "seems to me to teach, in the highest and strongest manner, the great truth which is embodied in the Christian conception of entire surrender to the will of God" (i. 219). "I have the firmest belief," he continues, "that the Divine Government . . . . is wholly just." There is a very interesting passage, too long to quote (ii. 303), in which he points out that "the best theological teachers . . . . substantially recognise these realities of things, however strange the forms in which they clothe their conceptions." For my own part, I wish he had applied the principle which is implied here in some of his controversial essays. Writings thousands of years old would have been unintelligible if they had not been expressed not merely in the language but in terms of the ideas current at the time. The demonology of the first century was scarcely worth the powder and shot bestowed upon it. If it had cost Huxley himself "many a struggle to get free" from the Pentateuchal cosmogony (i. 167), he lived to see Canon Driver give up its "physical truth . . . . altogether" (ii. 218); the process of attrition of what is superfluous will go on.

Huxley, however, in his episcopophagous mood was a grievous disappointment to extremists when it came to practical business. It is difficult, I think, to exaggerate the importance of the work he did on the London School Board and at a terrible cost to his health. He expressed "his belief that true education was impossible without 'religion,' of which he declared that all that is unchangeable in it is constituted by the love of some ethical ideal to govern and guide conduct" (ii. 340), and he unhesitatingly adopted the words of Mr. Forster in 1870:—

"I have the fullest confidence that in the reading and explaining of the Bible what the children will be taught will be the great truths of Christian life and conduct, which all of us desire they should know" (ii. 344).

He fought, therefore, "for the retention of the Bible, to the great scandal of some of my Liberal friends," and "never had the slightest sympathy with those who, as the Germans say, would 'throw the child away along with the bath'" (ii. 9).

Years after he remained of the same mind:—

"I do believe that the human race is not yet, possibly may never be, in a position to dispense with it" (ii. 300).

Ethical and religious problems occupied so large a place towards the end of Huxley's life that it was impossible to leave them out of sight. But a sharp distinction is, I think, to be drawn between what he accomplished in this field and what he did for knowledge. The latter was eminently constructive: he reconstituted biological science in this country from the foundations upwards. The former was only critical and, as he did not deny, mainly negative. His defence was that his part had been to clear "the ground for the builders to come after him" (ii. 301). Meanwhile he had nothing but respect for those who honestly held opposite views. But he would have nothing to do with the "half-and-half school," with whom he had less sympathy than "with thorough-going orthodoxy" (i. 471). For Magee, Bishop of Peterborough, he had "a great liking and respect" (ii. 244). I wish I felt at liberty to amplify what is said (ii. 205) as to the admiration he conceived for Father Steffens.

Looking back on the whole story as I have attempted to tell it, I am struck with the character of inevitableness about Huxley's career. I do not call to mind any other in which a controlling purpose so definitely manifests itself. "My sole motive," he said in 1891, "is to get at the truth in all things. I do not care one straw about fame, present or posthumous" (ii. 281), and certainly, so far as it is given to any one to be successful, he obtained a large measure of success.

Much has been said of the odium and obloquy he encountered in the process. He was certainly supremely indifferent to both, and probably rather enjoyed them. But Englishmen will concede anything to honesty, and Huxley was transparently honest. And obloquy is perhaps not intolerable which is accompanied by the repeated offer of a professorship at Oxford, followed by that of the headship of a college, by the presidency of the Royal Society, and by admission to the Privy Council.

But it was not merely as a man of science and of affairs that Huxley achieved success. He was possessed of an extraordinary literary gift. "I have," he writes, "a great love and respect for my native tongue, and take great pains to use it properly" (ii. 291). It is much to be wished that scientific men generally would follow his example. He could always, says Sir Spencer Walpole, "put his finger on a wrong word, and he always instinctively chose the right one" (ii. 25). But this, like everything else that he ever did, was not accomplished without labour. It was from the literature of the eighteenth century that young Englishmen "would learn to know good English when they see or hear it" (ii. 285). In his own case it helped to make him, as Mr. Arthur Balfour said, a great master of English prose; perhaps even, as Sir Spencer Walpole thinks, "the greatest master of prose of his time" (ii. 25).

Nor less sedulously did he cultivate the art of oral exposition and of public speaking, or with less success. Lord Salisbury exclaimed, "What a beautiful speaker he is" (ii. 25). Apart from eloquence as it is ordinarily understood, or rhetorical effect, I myself have never heard any one who in method or manner could compare with him. It is quite consistent with this that he should say, "I funk horribly, though I never get the least credit for it" (i. 311). Before one of his greatest performances he asked me to take his hand: it was stone-cold. "It is always like that," he said. Yet he held an enormous audience enchained while he unfolded, using no notes, but with faultless choice of words, an intricate and technical argument.

Nor was he less captivating in conversation. He rises to my mind's eye, drawing down his mouth when he was serious, as if to give momentum to the propulsion of the thought. In a moment, as some humorous aspect of the matter struck him, it would relax into a smile, and then, if one tried too audaciously to attack his arguments, his head would go back with a leonine sweep, as much as to say, "young man, be careful." But it was what Mr. Skelton admirably calls "the Shakespearian gaiety of touch" (ii. 16) that made converse with him so unforgettable. Darwin had something of it, but attuned to a gentler key. With Huxley it was irrepressible. "I suppose," he says, "I shall chaff some one on my death-bed" (ii. 76).

But, in truth, through these two volumes there runs a tragi-comedy, often moving to mirth and not seldom to tears, and sometimes almost Meredithian in intensity. The demon of dyspepsia broods over the drama, as it unfolds, like fate. The wonder is that a man who fought such a life-long battle with ill-health could oppose such a courageous and uncomplaining front to the outside world. He carried the fox gnawing at his vitals with a Spartan fortitude.

And to ill-health there was added, for no small portion of his life, the no less uncomplaining struggle with poverty. To keep his brother's widow he was even compelled to part with his Royal medal (i. 248). When he retired from the public service it was the desire of the Education Department that he should do so on a full pension. This the Treasury were unable to grant. But it is to be counted to the credit of a Tory Government that the amount was eventually made up from the Civil List.

A few words and I have done. In these volumes the reader has the privilege of being brought into as frank an intimacy with Huxley as was enjoyed by even his closest friends. I am wholly mistaken if there does not emerge from their perusal a personality of singular fascination behind which lay an intellectual and moral force, second perhaps to none in its influence on his countrymen during the latter half of the century which has closed.

As Lord Hobhouse has said, "he fought the battle of intellectual freedom" (ii. 407), and his success was due to the integrity of purpose and dauntless courage which never failed him. Sir Spencer Walpole says justly,

"Of all the men I have ever known, his ideas and his standard were—on the whole—the highest" (ii. 27).

He proceeds—

"He recognised the fact that his religious views imposed on him the duty of living the most upright of lives."

A very unfair use has, I think, been made of this opinion, which I am persuaded is based on a profound misconception. However derived, it is in an innate sense of moral beauty that I prefer to find the true secret of Huxley's life. W. T. THISELTON-DYER.

TERRESTRIAL MAGNETISM AND ATMOSPHERIC ELECTRICITY.

The Norwegian North Polar Expedition, 1893-96. *Scientific Results.* Edited by Fridtjof Nansen. Vol. ii. (London: Longmans, Green and Co., 1901.)

Report on Observations in Terrestrial Magnetism and Atmospheric Electricity made at the Central Meteorological Observatory of Japan for the Year 1897. Pp. 60. (Tokio: Central Meteorological Observatory.)

THE first of the above volumes consists of three memoirs, numbered VI., VII. and VIII., written respectively by Prof. H. Geelmuyden, Mr. Aksel S. Steen and Prof. O. E. Schiøtz. In a brief preface Dr. Nansen states that the great majority of the observations dealt with were made by Captain Sigurd Scott-Hansen.

VI. *Astronomical Observations.*—In a preface, pp. vii. to lx., Prof. Geelmuyden describes the astronomical instruments and the circumstances of their use. His principal object is to determine the drift of the *Fram* and the track of Nansen and Johansen after leaving the ship. The results are embodied in two large scale charts (in a pocket at the end of the volume). A second object is to determine the azimuth in connection with the observations of magnetic declination.

The latitude and local time were found by altitude observations, the sun alone being available during part of the year. For the determination of longitude, and of the chronometer rates, a variety of data were accumulated. There were observations during two eclipses, a few lunar distances and a number of observations of eclipses of Jupiter's satellites. In connection with these last data there is an enumeration of corresponding observations at various observatories, and a discussion of the theory and of various sources of uncertainty. The differences between the chronometers in use from 1893 to 1896 are recorded and discussed. The difficulties met with in reducing the astronomical observations are considerable. Most referred to a station in motion, while many were taken at extremely low temperatures, under conditions when ordinary astronomical formulæ for refraction, &c., are open to question. The differences between the chronometers are not always easy to explain, and the data as to their temperature corrections are somewhat uncertain. As to the data obtained by Nansen and Johansen in their journey, in Prof. Geelmuyden's words,

"the observations during this expedition, where the principal work of the travellers was very often a struggle for life, and where the instruments had to be handled in temperatures down to $-40°$ C., with no other source of heat than the observer's own body, could not attain any high degree of accuracy" (p. lvii.).

The fact that the observations were made at all is the strongest possible evidence that scientific zeal is compatible with the possession of remarkable physical courage and resolution.

After Geelmuyden's preface follow tables, pp. 1-136, giving full details of all the astronomical observations, with a few explanatory notes.

VII. *Terrestrial Magnetism.*—In his introduction, pp. 1-9, Steen describes the instruments. Acknowledgment is made of the assistance rendered by Dr. Neumayer, of Hamburg, who selected the apparatus and had some of it made under his own eye. The great majority of the observations were taken on the ice, inside a tent or a house of snow or ice. "As a defence against bears . . . a weapon was always at hand, generally a revolver." The position of this useful but embarrassing auxiliary and its influence, or absence of influence, on the magnets is a frequent item in the observational records. The different magnetic elements are discussed separately. The declination observations occupy pp. 10-61. The majority were taken with a "Neumayer Declinatorium," of which the principal feature is that its magnet consists of "two laminæ, between which the mirror was fixed"; the magnet rested on a pivot, but could be inverted so as to determine or eliminate the collimation error. Declination results are also deduced from the deflection experiments, intended primarily for the determination of the horizontal force. There were in all about 130 days on which declinations were obtained. The *changes* observed during each of these days are shown graphically, occupying seventeen plates. The observations seldom extended over more than two or three hours on any one day, and in no case was there a continuous day's record. On November 24, 1894, in the course of fifteen minutes, the declination changed fully 26°. On no other occasion did the observed range exceed a quarter of this; but changes of 2° or 3° in the course of an hour or two were not uncommon.

The discussion of the horizontal force observations occupies pp. 62-126, the results being summarised on pp. 119-126. The apparatus was by Zschau. Observations of vibration and deflection were made much in the usual way. The moments of inertia of the two magnets used had been determined, but only approximately, and instead of employing the values so calculated use is made for each magnet of a "constant," involving the moment of inertia, which was determined by observations made at Hamburg and Wilhelmshaven. In some instances the horizontal force is deduced from a deflection experiment alone, by means of a second "constant" involving the magnetic moment of the deflecting magnet. The times of vibration were taken without a telescope, and no observations were made on the torsion of the silk suspension. Mr. Steen also experienced some trouble in connection with the temperature coefficients, which had not been determined at Arctic temperatures.

The inclination observations are discussed on pp. 127-165. The instrument used was a Fox circle, as modified by Neumayer, with two needles and deflectors. In all there were ninety-two observations of inclination. In treating them, Mr. Steen encountered difficulties. In general, the magnetic axis of a dip needle is inclined to the line of geometrical symmetry, the position of which is read, while the C.G. departs from the axis of rotation. The former source of index error is usually eliminated by reading the needle with its face alternately towards and away from the face of the circle; whilst the latter source of error is removed by reversing the needle's magnetisation in the middle of each experiment. The needles, however, of a Fox circle are never reversed, and the observer in the present case had always used the needles in an invariable position. Assuming constancy in the magnetisation, the error from the first source would remain constant, but that from the second source would vary with the inclination. The resulting error is represented by Mr. Steen through a formula involving three unknown constants, but he finds the data insufficient for determining these directly. Eventually, by having recourse to some results obtained with the deflectors of the Fox apparatus and to corresponding values obtained for the horizontal force, and making certain assumptions, he arrives at numerical results. Some doubt may, however, be felt as to the measure of success attending Mr. Steen's courageous efforts, and this is the more to be regretted because the index correction applied averages about 50′.

The total intensity is dealt with on pp. 166–180. A considerable number of observations had been made with the Fox apparatus; the data, however, for converting these to absolute measure were not, in Mr. Steen's opinion, satisfactory. Accordingly, he contents himself with a list of the observational results,

"partly for possible future utilisation, and partly, too, to show what might have been done with the instrument if the necessary determination of the constants had been forthcoming" (p. 168).

Mr. Steen finishes with two tables, the first, pp. 183–188, summarising the individual results for the magnetic elements, along with the corresponding *theoretical* results, which Dr. Ad. Schmidt had the kindness to calculate from his values of the Gaussian constants for the epoch 1885. The discrepancies, which in the case of both the horizontal force and the inclination seem always of one sign, are often considerable. This may be partly due to the secular change, for which no allowance could be made. The second table arranges the observational results in groups.

VIII. *Pendulum Observations.*—Prof. Schiøtz in his introduction describes the apparatus, which consisted of a von Sterneck's outfit with two half-second pendulums. The periods were observed at Vienna, also at Christiania before and after the expedition, and Schiøtz concludes that practically no change had occurred. During the expedition one observation was made on shore near the Kara Sea, three on the ice, and seven inside the *Fram* when frozen in. Particulars of each experiment are given in full. The geographical coordinates of the stations and the corresponding times of swing are summarised on p. 55. To deduce absolute values for *g*, Schiøtz utilises the times of swing observed at Vienna and Christiania, together with the absolute values found for gravity at these places by von Oppolzer and himself. The values thus deduced for gravity at the polar stations are compared on p. 60 with the theoretical values given by Helmert's formula for *g*. Of the ten experiments taken on board ship or on the ice, five give values above and five values below the theoretical. The mean departure from the theoretical values, taken irrespective of sign, amounts only to three parts in 100,000; on the average the observed value exceeds the theoretical by one part per 100,000. Schiøtz believes, however, that the irregular movements due to ice motion must have slightly increased the observed values of *g*. His conclusion on p. 63 is as follows:

"The observations show that gravity may be regarded as normal over the polar basin; and as it is not probable that this is a peculiarity of the Polar Sea, we are led to the assumption that gravity is normal all over the great oceans. The increased attraction observed on oceanic islands must, therefore, only be due to the local attraction of the heaped up masses . . . that form the islands."

Prof. Schiøtz seems here rather a long way from his base. He devotes pp. 63–86 to drawing "some conclusions respecting the constitution of the earth's crust." A supplement, pp. 87–90, advances arguments which, in Schiøtz's opinion, justify the belief that the influence due to the lack of absolute rigidity in the supports on the pendulums' periods was the same throughout the voyage as at Christiania.

The writers of the three memoirs have clearly acted on the view that the circumstances of Nansen's polar journey were so unique as to justify an unusual amount of detail in recording the observations, and they have spared themselves no trouble in their anxiety to utilise the data to the very utmost. A critic may perhaps, however, be pardoned the doubt whether greater compression of details and greater reserve in theoretical deductions might not have led to a work of fully greater utility. Be this as it may, the volume is to be welcomed as exceedingly opportune in view of the approaching Antarctic expeditions. Those responsible for the exercise of foresight in connection with the apparatus, or the observational programmes of these expeditions, would be well advised in giving its contents their careful consideration.

According to the preface of the second work mentioned at the head of this notice, the Central Meteorological Observatory of Japan, at Tokio, was established in 1890, and "was rebuilt in July, 1897." (?) It possesses two underground magnetic rooms, one for photographically recording, the other for eye-reading, instruments. The former set of instruments are Mascart magnetographs, the latter are said to be of a similar type. The instruments for absolute observations are illustrated in a plate at the end of the volume. The declination and horizontal intensity are observed with an instrument due to Prof. Tanakadate, possessing some unusual features, of which a fuller description is given in the *Proc. R.S.E.* for 1884–6. The times required for taking the several observations are given as: declination, 5 minutes; horizontal force, 20 minutes; inclination, 20 minutes! Absolute observations are taken on only one day a month, but the operations are repeated several times; there are also monthly determinations of the curve scale values. The necessary temperature corrections are based on direct experiments on one occasion when the magnetograph room was artificially heated. Hourly measurements are made of all the magnetic curves and the results appear in tables, one for each element for each month. In addition to the hourly readings, each table gives the daily mean, maximum, minimum and "range" (maximum less minimum); it gives also the monthly mean for each hour of the day, and the means for the month of the diurnal maxima, minima and "ranges." The general character of each day, whether quiet or more or less disturbed, is also noted. The monthly means are summarised on p. 59, and there are curves of diurnal variation for each month and for the year.

The mean monthly diurnal variations are also analysed in Fourier's series. The fact should be noted that the "mean range" of any element for each month being the mean of the differences between the daily maxima and minima, irrespective of the times of their occurrence, is necessarily larger than the range shown in the mean monthly diurnal variation; it may be largely influenced by the occurrence of magnetic disturbances. For instance, the "mean range" in the horizontal force is given as greater in December than in any other month except April, but the value in December is considerably affected by the occurrence of two or three exceptionally large "ranges." The mean monthly diurnal variations are less exposed to accidental influences; their nature is most easily followed in the curves. The amplitude of the regular diurnal variation in both declination and horizontal force appears least in November. The amplitudes in January appear surprisingly large compared to those in the last three months of the year.

The atmospheric electricity installation consists of a Kelvin water-dropper, the discharge tube of which projects "about 2 metres" at a height of 1·7 metre above the ground. This is connected to the needle of a quadrant electrometer, the quadrants of which are connected the one pair to the positive the other pair to the negative pole of a battery of water cells, the centre of which is to earth. This seems the same arrangement as at Kew. The scale value of the curves is determined weekly. The hourly readings are recorded in tables, one for each month. The daily means, maxima, minima and "ranges" are recorded as in the magnetic tables, also the nature of the daily weather. Hourly means are also given for each month, but in forming these a considerable number of individual results are omitted as being abnormal. Amongst the values omitted are most of the negative potentials, and some entire days are excluded on which negative readings were numerous. The measurements of potential being all given in volts, one can follow readily the annual change, which is more than usually pronounced. Thus the mean potential for the year being 47·2 volts, the mean voltage for the three months December to February was 93·2, while that for the three months July to September was only 9·0; the maximum monthly mean was 112·8 in December, the minimum 6·9 in August. It may be added that the exceptionally low value in August appears in no way due to exceptional occurrences of negative potential.

The mean diurnal variations for the several months are illustrated by curves. As usual there is a marked tendency to a double diurnal variation; but the principal maximum occurs between 6 and 8 a.m., instead of, as is customary, in the late evening. Further, the principal minimum is found, the whole year round, in the early afternoon, usually from 2 to 3 p.m. These results possess a special interest from their apparent irreconcilability with views due to Chauveau which have recently met with considerable recognition.

Another notable feature is the size of the mean diurnal variation. The largest mean hourly value of the potential is in most months some four or five times the smallest; for instance, amongst the mean hourly values in December the maximum was 187·6, the minimum 42·1, while the corresponding values in August were 13·7 and 2·8. The peculiarities shown by the atmospheric electricity results at Tokio are, to a considerable extent, manifested by observations made during a series of years in the Batavia Observatory, but though Batavia is much nearer to the equator than Tokio, the results at the latter station show the greater departure from those ordinarily recorded in Europe.

What has been said will suffice to show the interest of the volume, and the evidence it affords of the progressive spirit in Japanese science. The continuance of the observations, and also of the practice of describing them in English (sometimes with Japanese equivalent), is much to be desired. There are, however, one or two points where some friendly criticism may be offered. The variation in the scale value of the horizontal force curves —from $10^{-6} \times 69$ to $10^{-6} \times 57$ C.G.S. units for 1 mm.—is excessive; and the vertical force scale values show even larger variations (1 mm. $= 10^{-6} \times 82$ in April, $10^{-6} \times 239$ in June, and $10^{-6} \times 79$ in November). Changes such as these, unless produced designedly at known times, introduce uncertainties into at least the annual variation in the amplitudes of the diurnal inequalities. Again, the temperature coefficients are so large for both the horizontal and vertical force magnetographs that appreciable uncertainty must be introduced into the diurnal variations unless the changes of temperature are known with extreme accuracy. Under such conditions, the employment of *six* significant figures in the tables of monthly means of the diurnal variations of the force components seems hardly well advised.

In the case of atmospheric electricity, 1 mm. of curve ordinate answered, on the average, to 3·86 volts in February, 1·15 in August and 2·69 in December. If, as one would rather *infer* from the preface, the number of battery cells in use varied from 30 to 50, one would not be surprised at a considerable change in the scale value, and it would be only good policy to have the scale contracted in winter when the mean potential is large. The changes recorded in the scale value seem, however, too large to be wholly accounted for in this way, and they do not exhibit so regular a fluctuation as to suggest design. A little further information on these points would enable the critic to pronounce with greater assurance on the value of the results.

C. CHREE.

STORAGE RESERVOIRS.

Reservoirs for Irrigation, Water-Power, and Domestic Water-Supply. By James D. Schuyler, M.Am.Soc. C.E. Pp. xviii+414. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1901.)

THE title-page of this book states that it also contains "an account of various types of dams, and the methods and plans of their construction; together with a discussion of the available water-supply for irrigation in various sections of arid America; the distribution, application, and use of water; the rainfall and run-off; the evaporation from reservoirs; and the effect of silt on reservoirs." The book was, accordingly, designed to embrace all the main questions relating to the construction of reservoirs, together with the distribution and use of the water stored up; but in reality the different methods of construction of reservoir dams, descriptions of numerous examples in the United States, and references to the works required for several projected reservoirs constitute the principal subjects dealt with. The most remarkable feature, however, of the book is the abundance of views of reservoir dams, reservoirs, and proposed sites for reservoirs, comprising a large proportion of the one hundred and eighty-three illustrations, which should prove very attractive to the general public; whilst the plans and sections of dams and other contingent works, maps of reservoirs and of proposed sites for reservoirs with contour lines, and twenty-five folding plates, in an appendix, of reservoir sites in California and the Lahontan and Arkansas River basins, and of the Sun River system of reservoirs in Montana, will appeal mainly to engineers.

The book is divided into only six chapters, treating respectively of Rock-Fill Dams, Hydraulic-Fill Dams, Masonry Dams, Earthen Dams, Natural Reservoirs, and Projected Reservoirs, to which an appendix is added containing particulars of reservoir surveys and designs in California, Nevada, Colorado, Montana, Utah, New Mexico, and Arizona, and the cost of reservoir construction per acre-foot in the United States and other countries.

Rock-fill dams of a temporary character, formed of timber cribs filled with stone, were originally used in California for impounding water for mining purposes; and subsequently more serviceable and more watertight dams were obtained by introducing some dry stone walling in front of a loose stone embankment, faced with two or three thicknesses of planks. Since then the loose stone embankment has been made more durable by facing it with asphalt concrete, or Portland cement concrete, or steel plates, laid on a sloping dry wall, or by introducing a central core of steel plates, or by a facing of masonry backed with earth, or by facing it with earth. Examples of these various types of rock-fill dams are described in the first chapter; and the extent of irrigation effected by means of the water stored up by these dams is indicated. Naturally dams of these economical types, imposed sometimes by the inaccessibility of the site and the necessities of the case, and occasionally very carelessly constructed, have not been exempt from failures, their bursting having been sometimes accompanied by disastrous results.

In a few instances, reservoir dams have been formed in the United States by directing a powerful jet of water against the upper slopes of a valley, and thus causing the materials scoured from the hillsides to be conveyed by the water to the site of the dam proposed to be constructed across the lower part of the river valley. By suitable arrangements, the stream of water from the issuing jet both conveys the materials by gravity to the required site, depositing them along the lines of the two slopes which are kept higher than the centre of the embankment, and consolidates these materials in position, the larger stones being dropped at the sides, and the finer materials being carried towards the centre of the dam in drawing off the water through standpipes. The best materials for this hydraulic-fill construction are a mixture of soil, sand, and gravel of various sizes; and examples of dams in the United States constructed successfully by this method are given in the second chapter. Both rock-fill dams and hydraulic-fill dams exhibit the peculiar resource and boldness of American engineers; though Canadian engineers have resorted to the hydraulic system for the formation of permanent embankments on the Canadian Pacific Railway, in place of the temporary wooden trestle viaducts provided at the outset for crossing valleys and gorges rapidly and economically.

The conditions of stability of masonry dams, involving a solid rock foundation, and a well-established profile in section varying with the height, have been so fully recognised for many years past, and any considerable departure from them appears so certain to result in failure, as illustrated by the history of the Bouzey dam in France, which gave way in 1895, that there might seem to be little scope for novelty in such constructions. Whereas, however, in European practice the curvature of a masonry dam in plan has generally been merely regarded as conferring an additional element of stability on the dam, American engineers have not hesitated to rely largely on the arched form for the stability of some dams, which have been given such slight sections that they could not possibly have resisted the water pressure unaided. This is exemplified to some extent by the slender Sweetwater dam, 90 feet high and only 46 feet thick at the base, and curved to a radius of 222 feet; and more especially the Bear Valley dam, which, though only 64 feet high, has been made unprecedentedly slight with a thickness of only 8½ feet 48 feet down from the top, where it rests on a masonry base 13 feet thick, so that its section is absolutely at variance with correct principles, and it would long ago have been swept away had it not been curved up-stream with a radius of 335 feet. The Zola dam in France was constructed about 1843, twenty-three years before French engineers inaugurated the correct profile for masonry dams by the completion of the Furens dam with ample stability in 1866, though retaining a maximum head of water of 164 feet; but unlike this latter dam, the Zola dam owes its stability entirely to its arched form in plan of 158 feet radius, coupled with the very short length of 23 feet at its base; for the Zola dam, though 120 feet high and 19 feet thick at the top, is only 49 feet thick at its base, showing that no approximation to the correct section had been reached at that period for what the author calls "gravity dams," supporting the water pressure by their weight alone.

Several examples of masonry dams in the United States are described and illustrated by views, sections, and plans; whilst short references are made to the most notable masonry dams in other countries. La Grange dam in California, for diverting the water of the Tuolumne River for irrigation, 125 feet high, resembles the Vyrnwy dam in section, the outflow in both cases taking place over the top of the dam. The San Mateo concrete dam in California, designed to have a height of 170 feet, but stopped at present at 146 feet, and a total length at the higher level of 680 feet, has a bottom width of 176 feet, and is arched up-stream with a radius of 637 feet; and the reservoir formed by the completed dam will have a capacity of 29,000 million gallons. The Ash Fork steel dam, 184 feet long and 46 feet high for a central 60 feet, built in 1897 across Johnson canyon in Arizona, is a novel type of dam, constructed with triangular steel frames covered with steel plates; but the experiment has not proved satisfactory, as the steel dam leaks considerably at its junctions with the masonry buttresses at both ends, and with the concrete foundation at the base. An interesting form of the failure of a masonry dam is furnished by the history of the Austin dam in Texas, illustrated by views, 1091 feet long and 68 feet high, built in 1891-92 and founded on limestone rock. In April, 1900, an unprecedented flood of the Colorado River raised the water-level of the reservoir 11 feet above the crest of the dam; and 500 feet of the dam slid forward on the foundation about 60 feet down stream, though a flood in the previous summer, raising the water 9⅕ feet above the crest, had passed down without injuring the dam. Another interesting feature of this work was the filling up of over two-fifths of the reservoir capacity with sand and silt in four years, owing to the yearly discharge of this sediment-bearing river amounting to about forty times the capacity of the reservoir.

Some earthen dams constructed in California and Colorado, for forming reservoirs for irrigation, are described in a short chapter. Natural reservoirs in the great plains to the east of the Rocky Mountains, formed by depressions collecting the storm waters from the adjacent districts and devoid of an outlet, can be readily utilised for irrigating arable lands at a lower elevation; and examples of such reservoirs are described in the fifth chapter. The final chapter is devoted to schemes for reservoirs, mainly in California, Colorado, Montana, New Mexico, and Utah, and like the preceding chapter possesses mainly a local interest; but the descriptions serve to show what a field there is in these Western States for such works, and what a large development of irrigation, with its attendant benefits, may be accomplished in these regions.

OUR BOOK SHELF.

The Anatomy of the Cat. By Jacob Reighard and H. S. Jennings. Pp. xx + 498. (New York: H. Holt and Co., 1901.)

YET another book upon the cat! With the great treatise of Strauss-Durckheim, and the books of Mivart, Wilder and Gorham, published, and the great work of Jayne in course of publication, there would seem little room left for this now before us. When, however, it is remembered that the treatise of the first-named author is not available for American students; that, like that by Wilder, it deals only with parts of the animal described; that the late Dr. Mivart's book, rather a general treatise on mammalian morphology than a special one upon the cat, fails completely in most parts where anatomical detail peculiar to this animal is concerned; that the book by Messrs. Gorham and Tower, though a laboratory treatise, is but brief—it will be clear that ample room is left for the work under review, which is designedly a laboratory book, giving a complete and well-balanced description of the facts of anatomy of the animal concerned "in moderate volume and without extraneous matter."

There are in all 472 pp. in the book, of which the appendix of 44 pp. is wholly given to directions for practical dissection. The body of the work consists of brief but concise descriptions of the organic systems taken in order—the skeletal, muscular, visceral, circulatory, nervous and sensory systems (the latter with the integument) being in turn dealt with. Anatomical characters are alone recognised; neither those histological nor which concern growth stages of even the bones are in any way given; nor is there any reference to literature beyond brief mention of the works by the aforenamed anatomists and some few others, together cited in the preface. Our authors have done well to consult the myological observations of Windle and Parsons, but they have omitted to even record the important work upon the morphology of the digestive tract of the cat, by Dr. Franklin Dexter, of the Harvard Medical School, which has been progressing side by side with their own.

This book is what it professes to be—a laboratory treatise, clear, deliberate and clean cut, in its style and method most nearly akin to the didactic laboratory treatises of the late Milnes Marshall, so fully in vogue by the type of student who cares only for facts. It is based upon an earlier account of the anatomy of the cat, designed by the senior author for class use in the University of Michigan in 1891-92. The junior author is responsible for its completion for publication, and the 173 text illustrations, which, though clear, are in no way remarkable, have been prepared under his supervision by his wife.

The chief novelty of the book is a system of nomenclature, based upon that proposed in 1895 by the German Society of Anatomists. A large section of the preface is devoted to a discussion of this and cognate subjects; the use of Latin terms in their English form, and the significance of topographic terms and terms of precise orientation, being among the more important topics discussed.

We are informed that the notes which furnished the basis of the book have been used with success in four or five of the American Universities, and although among English teachers, who prefer the rabbit to the cat for educational work, the book will be little in demand, it will be welcome beyond those upon the cat hitherto in use on account of its accuracy of descriptive detail and uniformity of treatment.

Essays in Illustration of the Action of Astral Gravitation in Natural Phenomena. By William Leighton Jordan, F.R.G.S., M.R.I., Assoc.Inst.C.E., F.S.S., F.S.A., F.R.M.S. Pp. xv + 192. (London: Longmans, Green and Co., 1900.)

WHEN an author puts forward perfectly new views in opposition to those generally accepted, using technical terms like *force* and *energy* in several new senses, it is very difficult to find out exactly what he means. In his definitions he says that gravitation resists all impressed motion with a force as the square of the velocity. He defines *vis inertiae* as the force with which matter resists motion. It is as the mass multiplied by the square of the motion resisted. After defining momentum, he says that it is resisted by the inertia of matter in its origin and in its progress, whereas Newton's first law of motion supposes inertia to resist its origin but to sustain its progress. The author's membership of many learned societies might warrant the belief that he has some meaning in what he says, but it is certainly very carefully concealed.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The National Antarctic Expedition.

I HAVE recently been made acquainted with certain hypotheses which are believed to explain the motives which induced Prof. Gregory to resign the position of scientific director of the National Antarctic Expedition. Thus, it is commonly believed that he was influenced by his family and friends. Indeed, the opinion has recently been expressed that I was, perhaps, the cause of his withdrawal, or that, at least, I advised it. It is impossible to imagine how such an opinion can have arisen if my letter to the Fellows of the Royal Society had been read with any attention, unless, indeed, I have failed to give a fair and accurate account, in spite of most serious efforts, put forth with a grave sense of responsibility.

I am, however, now able to set the matter at rest by a quotation from Prof. Gregory's letters received since the circulation of my account of the negotiations. I am quite sure that Prof. Gregory would have no objection to this use of his words in order to confront the unfounded rumours which have obtained currency.

It may be remembered that after the meeting of the Joint Committee on March 5, at which Major Darwin's proposed changes in the conditions offered to, and accepted by, Prof. Gregory were approved, although I had strongly opposed the introduction of any alteration whatever, "I wrote to Prof. Gregory a full account of what had happened, carefully explaining that his representative and many of his friends supported the changes, that I had confidence that the proposal was made to enable the Geographical Society to accept the instructions, and that it was not intended to prevent, and, I believed, would not prevent, his being landed" (p. 6 of my letter).

I have now received two letters from Prof. Gregory, one written on April 16, before he had received mine, the other on April 23, after he had received it.

In the former he says: "I hear that the Joint Committee has accepted some of Darwin's amendments; but as I do not know what they were I can form no opinion. But ——, —— and —— say they make no difference. I hope not."

In the latter, written in reply to my letter, he says: "Very many thanks for your fight against Darwin's amendment, which I should not have accepted had I been in London or been advised of it by cable. However, I suppose it is now too late to go back on it; and as it has [been] accepted for me I must trust to luck."

Later on in his letter the explanation of his resignation becomes perfectly clear; indeed, he asks me to make it known. In the event of the President of the Geographical Society declining to sign the instructions, he says: "*Please let it be known that, except for a modification backward of Darwin's amendment, I will not accept another change.*"

Between my letter describing the meeting on March 5 and May 15, when his final resignation was known, I held no communication of any kind with him. But others had communicated those further changes which he was determined not to accept.

It must be clear to any one who will read the history of the negotiations carefully, that he thought, and had good reason to think, that he was being trifled with, and felt that the time had come—to a less patient man it would have come long before—when he would no longer submit to the vigorous attacks of the Royal Geographical Society and the weak, half-hearted defence of the Royal Society.

* * * * *

A few hours after the above words were written a letter arrived from Prof. Gregory dated May 5, just after he had received the cable from the new Committee of six. The letter indicates clearly the reasons which induced him to withdraw, and I therefore quote several passages from it. The letter was written hurriedly, and not intended for publication; but I know that Prof. Gregory would assent to my action, pursued as it is with the object of preventing the misinterpretation of his motives. A few unimportant verbal changes have been made.

"You at least," he says, "will not have expected me to accept the cabled terms. I was not surprised at them; only surprised that the Royal Society had given way apparently so readily and that I heard the result a month earlier than I expected."

"The terms proposed appear to me, as far as I understand them from the cable, a complete surrender of what the Royal Society's representatives declared in February was essential to the proper execution of the magnetic work. The position gives no power to secure a fair opportunity for work to the man who would have to bear the blame for scientific failure."

"To accept responsibility without adequate power is a false position which is almost sure to lead to trouble. No man has a right to take such a position. As I do not think the powers are adequate to the responsibilities, it is my simple duty to withdraw. I hope the Royal Society will find a better man, who will be satisfied that he can make the Expedition a scientific success on the instructions given. I am not; therefore I must withdraw my provisional acceptance of the appointment."

"It will be difficult to prevent my withdrawal being misinterpreted. I had thought of cabling to ask you to publish an explanation, but thought it best to leave you to act as you thought best. I can absolutely rely on your judgment, and know you will have done anything necessary to repel insinuations."

I have done my best to prevent Prof. Gregory's motives from being misunderstood, and it is with the same object that this communication is now written and accompanied by quotations from his letters.

He concludes with a reference, which is far too appreciative, to the support which—unfortunately for the scientific prospects of the expedition and, I must add, unfortunately for the credit of the Royal Society as the guardian of the interests of science—received, at the later stages of the negotiations, the help of so small a proportion of my colleagues.

Oxford, June 11. EDWARD B. POULTON.

A Raid upon Wild Flowers.

PROF. L. C. MIALL, in the last number of NATURE, makes very definite and serious charges against the organisers of the vacation course for Essex teachers in the New Forest. As author of the programme so severely, and, as I contend, unfairly, criticised by your correspondent, I should be glad to be allowed an opportunity for reply.

The programme, as you will see by the copy enclosed, consists of two parts, the first dealing with a series of Saturday afternoon botanical rambles in our own county and the other with the proposed vacation course to be held at the New Forest. The first is of a pioneer character, and is open to all teachers whether they are familiar with botany or not, while the vacation course is organised for those of our teacher-students who have already received one, two or more years' instruction in laboratory and field-work in botany at the central institution here. For this course special application must be made to the committee.

From a perusal of the programme Prof. Miall accuses the Committee for Technical Instruction in Essex with organising a raid in the New Forest especially upon wild flowers tending to extinction, and bases his charge upon certain alleged facts. Your readers are told that with respect to these rare plants our intention is to collect, &c., "not only single specimens but duplicates for special fascicles." There is no such reference in the programme of the vacation course in the New Forest, but in a note at the end of the Saturday afternoon programme occurs these words.

"Opportunity might be taken, during the course of the Saturday rambles, of commencing a school herbarium, or collection of dried plants illustrative of the flora of collector's own district. A type collection would naturally be arranged in botanical order, but duplicates might be used for special fascicles representing, for example, 'meadow plants,' 'cornfield weeds,' &c."

The letter continues—"Local guides are to direct them to the last retreats of the rare plants of the New Forest." This, too, is a mistake. In the Saturday afternoon rambles we are to be accompanied by local guides whose names and addresses are given in the programme, but no such arrangements were made for the New Forest. It is true that I sought the sympathy of local naturalists, and, indeed, so anxious was I to prevent even the suspicion of "raiding" that I wrote to the Rev. J. E. Kelsall, the local representative of the Selborne Society, whose strong views on the preservation of the plant and bird life of the New Forest are so well known, to tell him of our proposal and to assure him that our chief object was the study of living plants, and that if we discovered anything rare, or even scarce, it would be left untouched by our students; and I thought that the publication of the fact that Mr. Kelsall and Mr. Dale, secretary of the Hants Field Club, might be able "to accompany the party on one or more of its rambles" a sufficient guarantee that the rights of wild plants would be respected.

Furthermore, on the title page of the vacation course programme, p. 9, and printed in conspicuous black type, is the following notice: "Members of the party will, of course, refrain from uprooting rare or scarce specimens." Yet Prof. Miall alleges "there was no such restriction in the printed programme"!

In the daily itinerary as printed in the programme reference is made to the character of the scenery, the soil and surface geology, the prevailing vegetation, and to some of the rare plants growing in the neighbourhood. From what we have already shown it could hardly be our intention to raid these rare plants, and especially as several of those mentioned will be out of flower in August. Indeed, so particular are we in these rambles that the needless uprooting even of the commonest weed is discountenanced, as may be seen in the further notice on p. 3 of the programme.

In comparison with such a particularly odious charge as plant extermination, the other strictures of your correspondent's letter are, of course, scarcely worth noticing; yet even with respect to these I cannot resist pointing out that Prof. Miall's statements are strangely at variance with the actual facts. For example, he writes: "It is enough to condemn the programme as an educational project that novices knowing little or nothing of field-botany are set to study the subspecies of brambles." But does the programme so recommend? It distinctly says in reference to this (p. 18), that "their identification will give capital exercise in critical observation to the *more advanced worker*."

The real object of these field-studies, as stated on the front page of our programme, is to give teachers "an insight into the way in which plants grow, especially in their relations with their environment—the influence of external conditions, such as light, heat and moisture, upon their form, the mutual relationships between plants and animals and the influence of one organism upon another," and is in no way connected with collecting in the sense used by Prof. Miall. The vacation students have varied interests—flowering plants, algæ, leaf-fungi, &c., and the evenings are to be spent in discussing "the most interesting of the objects collected" and on the "preservation" of such as may be useful for class-work in the winter courses. Readers of NATURE will understand that work of this sort does not mean the collection of rare flowering plants.

Perhaps because of the peculiar gravity of the charge I may, in conclusion, be allowed to introduce one personal note into the reply. I should like to say that although I have conducted field studies in botany for the last twelve years (including two summer courses at the New Forest), yet, as it happens, I am no collector myself, and have never made what botanists would call a collection of dried plants in my life. Furthermore, I have never possessed, or even "coveted," a single specimen of a rare British plant. On the contrary, my sympathies are, of course, entirely with those who are opposed to any interference with our native flora, and I do most strongly protest against this attempt of Prof. Miall to connect in any way whatever our botanical work with such objectionable practices.

I should be glad to send a copy of the programme to any one who may care to see it. DAVID HOUSTON.

County Technical Laboratories, Chelmsford, June 10.

Emanations from Radio-active Substances.

IN a recent number of the *Comptes rendus* of the Paris Academy (March 25) an account appeared by MM. P. Curie and A. Debierne of the production of a radio-active gas from radium. In their experiments some radium was placed in a glass vessel and the air exhausted by means of a mercury pump. It was found that the vacuum steadily decreased, due to the giving off of a gaseous substance from the radium. A small amount of the gas thus collected was found to be strongly radio-active. It caused phosphorescence in the glass tubes over which it passed, and in course of time blackened them. Substances exposed in the gas became themselves temporarily radio-active.

Some time ago (*Phil. Mag.*, January and February 1900) I showed that thorium compounds continuously emitted radio-active particles of some kind, which preserved their radio-activity for several minutes. This emanation possessed the remarkable property of causing all bodies, in contact with it, to become themselves radio-active. In an electric field the excited radio-activity could be concentrated and confined to the negative electrode. In this way I was able to make a fine platinum wire become a very powerful source of radiation.

The excited radio-activity gradually diminished, falling to half its value in about twelve hours. The specimen of impure radium then in my possession gave out no emanation and caused no excited radio-activity. Later, Dorn, using the same methods, showed that a preparation of radium from P. de Haen, Hanover, gave out an emanation similar in properties to thorium. With a specimen of radium obtained from the same source I have found that the emanation given off is small at atmospheric temperature, but can be enormously increased by slightly heating the radium. In this way I have obtained ten thousand times the amount of emanation given off at ordinary temperatures. An account of these experiments is given in the *Physikalische Zeitschrift* (April 20).

By passing the emanation with a current of air into a closed vessel, and then closing the openings, the emanation remains radio-active for a long time. The radio-activity decreases slowly, but is still quite appreciable after an interval of one month. M. and Mme. Curies, some time ago, stated that they had obtained a radio-active gas which preserved its activity for several weeks; this is possibly identical with the emanation.

Up to this point I had been unable to obtain any definite evidence whether the so-called emanations were vapours of the radio-active substances, radio-active gases, or radiating particles large compared with a molecule. The radium and thorium, when placed in an exhausted tube, gave no appreciable lowering of the vacuum, and no new spectral lines could be observed. The quantity of substance emitted was too small to examine by chemical methods.

Quite recently, however, some light has been thrown on the question of the nature of these emanations by examining their rate of diffusion by an electrical method. In these experiments I have been assisted by Miss H. T. Brooks, and the results point to the conclusion that the emanation from radium is in reality a radio-active gas, with a molecular weight probably lying between 40 and 100.

There is one distinct feature which distinguishes the emanations from radium and thorium. The thorium emanation loses its radio-activity in a few minutes, while the excited radio-activity due to it lasts several days. The radium emanation, on the other hand, preserved its radiating power for several weeks, while the excited radio-activity due to it disappears in a few hours. In the following experiments it was only possible to experiment with radium emanation, on account of the rapid decay of radio-activity of the thorium emanation.

The diffusion apparatus was similar to that which had been employed by Loschmidt in 1870 in his determinations of the coefficients of interdiffusion of gases.

A brass cylinder, 73 cm. long, 6 cm. in diameter, was divided into two equal parts by a metal slide, which could be opened or closed. The ends were closed by insulating ebonite stoppers, through which passed central rods half the length of the tube. In order to introduce the emanation into one half of the cylinder the slide was closed, and a slow current of air, which had passed over slightly heated radium and thus carried the emanation with it, was passed through the cylinder. When a sufficient amount had been introduced the current of air was stopped and the openings closed. After standing for an hour or more the slide was opened, and the radio-active emanation slowly diffused into the other half of the cylinder. The amount of emanation in each half of the cylinder after any interval was tested by observing the current through the gas, when a suitable P.D. was applied, by means of an electrometer. The current is carried by the gaseous ions which are continually produced by the radiation from the emanation. From these observations the coefficient of inter-diffusion of the emanation into air at atmospheric pressure and temperature can be readily deduced. The experiments are, however, complicated by the excited radio-activity on the electrodes, which must be taken into consideration.

So far as the observations have gone up to the present, the coefficient of diffusion of the emanation into air has a value between 0·10 and 0·15, and probably nearer the former. Now the coefficients of inter-diffusion of some known gases and vapours into air have been determined. The following examples have been taken from Landolt and Bernstein's tables:—

Gas or Vapour.	Coefficient of Diffusion into Air.	Molecular Weight.
Water vapour	0·198 ...	18
Carbonic acid gas	0·142 ...	44
Alcohol	0·101 ...	46
Ether	0·077 ...	74

In the above we see that the coefficients of diffusion follow the inverse order of the molecular weights. In cases of the simpler gases it has been shown experimentally that the coefficient of inter-diffusion is approximately inversely proportional to the square roots of the product of the molecular weights. If we apply these considerations to the emanations we see that it is a gas or a vapour of molecular weight (allowing a wide margin) probably lying between 40 and 100. These numbers exclude the possibility of the substance being a vapour of radium, for it has already been shown by M. and Mme. Curie that the atomic weight of radium is greater than that of barium.

We must, therefore, conclude that the emanation is in reality a heavy radio-active vapour or gas.

On account of the rapid decay of the radiating power of thorium emanations it is not possible to determine its coefficients of diffusion in the same way; but special experiments show that it diffuses rapidly, and is also probably gaseous in character. The physical properties of these emanations or gases are most remarkable. The radium emanation not only continues for long intervals to be a source of radiation which is apparently similar in character to easily absorbed Röntgen rays, but in some way manufactures from itself a positively charged substance, which travels to the negative electrode and becomes a source of secondary radio-activity.

Space is too short to enter into the interesting question of the possible explanation of these complicated phenomena.

McGill University, Montreal, May 30. E. RUTHERFORD.

Long-tailed Japanese Fowls.

A LITTLE while ago in your columns Prof. Lankester referred to this breed as "a magnificent sport," and considered the occurrence of genius in mankind as a case of the same kind. In Newton's "Dictionary of Birds," article "Feather," it is stated that in these Japanese poultry the moult is checked or prevented by some means unknown to Europeans. It is obvious that the latter statement, if correct, is not compatible with Prof. Lankester's description. If the breed really arose as "a magnificent sport," I presume that the excessive growth of the tail coverts would be due to a spontaneous variation, and not to some artificial method of preventing the annual moult. After a great deal of trouble I have succeeded in obtaining evidence, which seems to me unimpeachable, concerning the means taken by the Japanese to produce this extraordinary elongation of feather in the cocks of the breed in question.

I will quote the words of my informant. He writes:—"With regard to the treatment of these birds, in order to ensure very great length of tail, they ought after they are six months old to be kept on a perch as much as possible, and the tail feathers should be pulled gently every morning, grasping the centre bone-like part firmly with the finger and thumb, and, pressing steadily, draw downwards towards the tip, each feather being done several times; this softens the quill and causes it to lengthen. They do not moult the feathers, but if one or more come out others immediately grow in their place. The Japs themselves, those who take great pride in their birds, always roll the long feathers up, like a lady rolls up her hair, and tie them, whenever they are let off their perches to walk about, which is about twice a day for an hour at a time. . . .

"I have often seen them thus treated in Japan, and the man who brought mine over treated them in this way on the voyage over, and I sent them (to purchasers) in their regular perch cages."

I think this, being the evidence of direct observation, is enough to prove that the length of feather in these birds is not correctly described as a "sport," but has been produced by special artificial treatment. The effect of the treatment is doubtless to irritate the papilla from which the feather grows, and so cause increased growth, rather than to soften and lengthen the already formed quill. The feathers appear to grow throughout the year, so that when the moulting season is reached they are not shed, but continue growing.

There is no doubt that the peculiarity is to a certain extent hereditary, but extreme length of feather cannot, I believe, be produced without the special treatment. These fowls have been bred in England, and I have seen specimens which had tail coverts (and also hackles) longer than those of any European breed, but so far as I know no specimens bred in Europe have produced the extraordinary length of feather that is known to occur in Japanese specimens, for example in the two stuffed specimens in the hall of the Natural History Museum. It seems to me reasonable to conclude that the hereditary effect is due to the artificial irritation applied to a long succession of generations.

Penzance, June 5. J. T. CUNNINGHAM.

Variation in a Bee.

ON September 24, some years ago, I collected at Mesilla, New Mexico, four examples of a wild bee of the genus Epeolus, the species being probably identical with *Epeolus bardus* of Cresson. In every one of these specimens the second transverso-cubital nervure is incomplete, its lower half being wanting, on one or both sides. In one example only is the nervure incomplete on both sides; in the other three it is incomplete on the right side only. Such aberrations are not very uncommon among bees, but they usually occur in single examples, and this is the best instance known to me of their being inherited by a number of individuals. What is here clearly a sport seems in a fair way to become a racial character, and we seem to have a good example of Bateson's "discontinuous variation." In the genus Halictus certain species have only two submarginal cells, instead of the usual three, and the same is true of Andrena. These peculiar species are related to different groups of the genera to which they belong, so that if it is proposed to regard them as pertaining to distinct subgenera (or genera) by reason of their venation, it becomes necessary to propose several subgeneric names instead of one, because of the independent evolution of the species. That this evolution has resulted from the perpetuation of sports such as that described above we can hardly doubt, but we are not thereby compelled to admit that it may not also be beneficial to the species.

T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., May 25.

Foreign Oysters Acquiring Characters of Natives.

THE facts contained in Mr. Tabor's letter, however interesting, supply no evidence for or against Lamarckism. When at Whitstable, the individual French oyster has certain characters impressed upon it by its environment. The next generation, when compared with the natives, show certain peculiarities, such as greater thickness of shell and greater growing power. But this also we are able to interpret as the reponse of the individual to the environment. If the peculiarities appear in many successive generations, the same explanation will account for the facts. If, however, Lamarckians could show that the effect of the environment, as the generations succeed one another, is cumulative, that the characters in question become *progressively* accentuated, then they would prove their case. But it does not appear that they have any such evidence at their command. F. W. HEADLEY.

Haileybury College, Hertford.

ITALIAN EXPLORATION IN ARCTIC REGIONS.

THE recent success of the Duke of the Abruzzi's expedition, which carried the Italian flag nearer the North Pole than ever flag flew before, has doubtless prepared a public in Italy for the literature of Polar exploration. The firm of Hoepli, who have conferred many favours on Italian-speaking geographers, have just published a history of Polar exploration in the nineteenth century by Signor Hugues.[1] The book makes no claim to originality, being merely a condensed popular description of the Polar voyages of the late century, and although more detailed on account of the shorter range of time dealt with, and coming down to the year 1900, it cannot compare with General Greely's compact handbook as a work of reference for the student. The most serious drawback is the want of a bibliography or a uniform

[1] "Luigi Hugues—Le Esplorazioni Polari nel Secolo XIX." Pp. xx + 374. Maps and Illustrations. (Milano: Ulrici Hoepli, 1901). Price 12 lire.

system of acknowledging sources of information. Another, which strikes an English reader, is the curiously unfamiliar aspect of well-known names of people and places in their Italian form—Giovanni Ross and Giuseppe Wiggins, Terra del Re Guglielmo and San Giovanni de Terranuova require some thinking over. Where so many personal names are foreign to the author, misprints may easily escape detection, and in the index a cursory inspection reveals about a dozen slips, of which the worst are Gordfelow for Goodfellow, and Newes for Newnes. Probably no English author could handle more than 600 foreign names with fewer accidents. Except for a tangle of dates on p. 98, and the necessary baldness in the treatment of some picturesque episodes induced by brevity, the narrative is clear, interesting and, so far as we can test it, correct. Most space is, of course, given to the Arctic regions; but the history of South Polar voyages is also summarised.

The members of the Italian Arctic expedition had a magnificent reception in Rome on January 14, the description of which, together with the addresses of the Duke of the Abruzzi and Captain Cagni, occupy practically the whole February number of the *Bollettino* of the Italian Geographical Society. The hall was splendidly decorated with flags and Arctic trophies; and the King and Queen of Italy, with other members of the Royal family, the great officers of State and the Diplomatic Corps, as well as the heads of the scientific bodies in Rome, were present.

The Duke of the Abruzzi described the equipment of the expedition and the voyage of the famous whaler *Jason*, renamed the *Stella Polare*, to her winter quarters in Teplitz Bay; and after Captain Cagni had told the story of his great sledge journey over the ice, H.R.H. resumed the narrative of his sojourn at the base and the return of the party to Europe.

The following is a brief summary of the facts:—

The *Stella Polare* left Archangel, where she had called for dogs, on July 12, 1899, and, after some delay in the ice, passed Cape Flora, in Franz Josef Land, on the 26th, sailed up the strait named by Jackson the British Channel and along the shore of the Queen Victoria Sea to a point in 82° 4′, just north of Cape Fligely on Prince Rudolf Island, which was reached on August 8th, after a good deal of trouble from the ice. Teplitz Bay, in 81° 47′, was chosen for wintering the ship; the dogs and stores were landed there, and the ship, having been damaged on September 9 by an ice-pressure, the party was obliged to land and live on shore. During the winter the Duke of the Abruzzi was severely frost-bitten in the hand and was obliged to abandon his intention of accompanying the sledge expedition to the north in spring. The command of this expedition accordingly devolved on Captain Cagni. The sledges used were of Nansen's pattern; the sleeping bags for the men were made of reindeer skin; pemmican was the chief food relied on, and petroleum was used for cooking. The expedition was marshalled in three divisions, each consisting of three men and four sledges, on which were placed 180 rations for men and 1150 for dogs. The provisions of the first division would suffice for the whole party for fifteen days after leaving the island, when the people of that division would return. The provisions of the second division would supply the two remaining groups for fifteen days more and then suffice to allow its members to return to the base, while the third group with their intact store of provisions should be able to push on for fifteen days more, or forty-five days from the base, before requiring to return.

In some preliminary sledge trips in February a temperature descending to −52° C. (−62° F.) was recorded, this being the lower limit of the graduation of the minimum thermometer. The start for the real attempt on the pole was made on March 11, 1900, when the caravan of three parties struck out boldly across the sea-ice, bound north, Captain Evenson and two sailors accompanying the expedition for two days with a thirteenth sledge. The advance at first was slow, on account of bad weather and rough ice. On March 22 the first division, consisting of Lieut. Quirini, the guide Ollier, and the engineer Stökken, left to return to Teplitz Bay. This party has never since been heard of, and there is little doubt that all three have perished. On March 31 the second group went back, and Captain Cagni continued on his way with three companions, Italian Alpine guides named Petigax, Fenouillet and Canepa. By sending back the other parties some days earlier than was at first intended he was able to retain a larger supply of provisions. Six sledges were taken on, and in spite of the difficulties of the way the party made excellent progress, and by reducing the rations they were able to continue the northward march to 86° 33′ 49″ in 64° 30′ E., which was attained on April 25. The journey at times was comparatively easy, the ice in places being smooth and covered with firm snow, but frequent pressure-ridges had to be surmounted and proved serious obstacles. In the latter part of the journey, when the temperature did not descend below zero Fahrenheit, lanes of water often opened with dangerous suddenness and caused great delay, while frequent gales and bad weather of every kind were encountered. The return journey, with rapidly dwindling provisions and diminished strength, was extremely laborious and the steady drift of the ice to the westward was a very serious difficulty, and, despite an increasing easterly component in the direction of march, the first land sighted was Harley and Neale Islands and Cape Mill, fifty miles west by south of Teplitz Bay. It was June 22 before the base was reached, and Captain Cagni had been absent 104 days, making (apart from the loss of the three men in the missing party) perhaps the most successful sledge journey ever accomplished in the Arctic regions, and certainly reaching the highest latitude.

The *Stella Polare*, after temporary repairs, was released from the ice with great difficulty, and only succeeded in getting away from Teplitz Bay on August 15, after which a good passage was made to Norway.

The results of the expedition are touched on slightly. Petermann Land and King Oscar Land, reported by Payer, have been shown not to exist in sight of the positions assigned to them. Cape Fligely (81° 51′) is proved to be the most northerly point of Franz Josef Land, and Cape Sherard Osborn does not belong to the same island, if it has any real existence. Doubt is thrown on the existence of the islands reported by Wellman north of Hvidtenland; but the maps of the Jackson expedition appear to have been found accurate so far as they could be tested. A year's meteorological and magnetic observations were obtained at Teplitz Bay, and gravity and tidal observations were also carried out. Prince Rudolf Island was found to consist entirely of basaltic rock. Animal life was not found very abundant, polar bears being the only common land mammals, and no new birds appear to have been discovered.

HAILSTORM ARTILLERY.

IN the absence of any recognised English equivalent for the expressive German term *Das Wetterschiessen*, I have thought it best in the heading of this article to avoid a literal translation of it lest it should give rise to misunderstanding. "Weather shooting" does not refer to any haphazard or empirical attempts to foretell the weather, but to a practice which has lately come to have great vogue in Styria, Italy and elsewhere of firing off charges of gunpowder to protect the vineyards against injury from hail. So popular indeed has the practice become in some districts that there is danger of the cost of the protection exceeding that of any damage likely to be caused by the hail.

The idea that the weather can be affected by the discharge of gunpowder is not a new one. There have been various traditions of rain falling after, and presumably in consequence of, the cannonade of a battle, and I have some recollection of an account in English newspapers of an American enterprise for terminating a drought by a sufficiency of gunpowder.

Weather shooting as now practised has, however, a more definite purpose than merely causing rain. Its object is to prevent the downpour of hail by shooting when thunder or hail clouds threaten. Even this form of the application of gunpowder to the management of the weather is by no means new. The *Meteorologische Zeitschrift* of March 1900 states, on the authority of Arago, that in the seventeenth century a fleet, anchored off Cartagena (South America), dispersed a daily afternoon thunderstorm by a daily bombardment; and Leonardo da Vinci is said to have asserted that damage by hail could be averted by mounting mortars on the hills from which the storm-clouds came and shooting at them. Quite early in the past century the matter was taken up in the neighbourhood of Macon. The recent development, which has spread very widely, is most conspicuously represented by the arrangements of Bürgermeister Stiger, of Windisch-Feistritz, in Styria, where they were originally introduced in 1896 in the form of a vine-dressers' volunteer artillery. Batteries of ten heavy mortars to take a charge of 120 grammes of powder, served by six men each, were placed at twelve separate stations within two square kilometres at a high level near Windisch-Feistritz. As soon as a downpour of hail threatened, the 120 mortars were fired "incessantly" until the danger was past. The second year thirty-three stations were at work, and the third fifty-six. It is reported that this energetic proceeding has completely protected the region from hail and has mitigated the damage from lightning; and as Bürgermeister Stiger apparently introduced the system as an alternative to covering the district with wire of close mesh, the damage must have been previously regarded as a serious matter. Other places have been less successful, and the Austrian Government and local authorities have taken steps to inquire into the effectiveness of the shooting. But the vineyard districts are not willing to wait for the report of the inquiry; they are satisfied that they only failed because they did not shoot early enough or often enough, and only desire to shoot more and oftener.

It is not quite clear how the effects of the shooting are manifested. In some cases it would appear that the shooting dispersed the clouds altogether, in others that it caused rain, sometimes heavy rain, sometimes a genial and welcome rainfall instead of the malignant pelt of the hail.

Dr. Pernter, of the Austrian Meteorological Department, was of the commission appointed to inquire into the matter, and in the September number of the *Meteorologische Zeitschrift* he gives a most interesting account of some experiments in connection with the inquiry. From that account it appears that there are three forms of apparatus employed, differing in size. A small cylindrical mortar with a large conical mouthpiece is the general form of the apparatus.

The conical portion of the smallest system (System Unger) is 2 metres long, that of the longest (System Suschnig) is 4 metres long; the former takes a charge of powder up to about 60 grammes, the latter up to about 250 grammes. Briefly, the latter is the most effective implement, and a charge of 180 grammes is the best suited for the purpose.

The effect of the shot is to produce, besides noise, a vortex ring of most impressive dimensions and energy. It would start with a loud hum and settle down to a whistle. When the gunpowder charge was most suitable, it would tear a thick paper screen to pieces at 100 metres distance from the mortar and pull the wooden framework of the screen apart and hurl the pieces about. Dr. Pernter, indeed, becomes quite eloquent in his description of the behaviour of these rings as astonishing physical experiments quite apart from any practical interest they may have as affecting the weather.

The position of the ring is recognisable by its whistle after it has become invisible, and its duration is estimated by the duration of the whistling. In the firing the rings are shot upwards, and it is assumed that the effect of the shooting depends upon them.

Dr. Pernter's experiments were directed mainly towards ascertaining the velocity and the length of the path of the rings, with the ultimate object of determining whether they could reach the levels of the lowest stratum of rain cloud. Determining the velocities from a very large number of experiments with charges of different weight, he obtained in the most favourable circumstances with the Suschnig apparatus an initial velocity of about 55 metres a second and a height of 400 metres as the extreme probable limit of the best shots. Thus the experiments seem to show that the rings would not reach the storm-clouds at the 1000-metre level, but as the local people were convinced from their own observations that the storm-clouds in the neighbourhood of St. Katherein (where the experiments took place) were to be found at 800 metres, and as the shooting-gear was fixed at elevations of some 500 metres, it seemed possible that the rings might just reach the clouds.

Such is the result of the investigation, with the addition that the smaller apparatus would not carry nearly so far, nor would the rings have anything like so much energy as those from the larger apparatus, whence it follows that if we wish to shoot the clouds effectively we must use the largest-sized mortars, taking 180 grammes of powder, and we should then be a little uncertain whether the ring would travel far enough.

Various theories have, of course, been suggested to account for the protection from hail alleged to be secured by this shooting. Supersaturated air from which the rain is liberated, a labile state of atmospheric equilibrium disturbed by the discharge, globules of overcooled water, still liquid below the freezing-point, which would form large hail-drops if they were allowed to coalesce but are solidified separately by the shock, and many other suggestions have been put forward as the state of things precedent to the hail shower, which is disarranged by the shooting. There seems, indeed, to be a disposition to see what curious conditions our present knowledge of the physics of the atmosphere can account for, and then wonder whether one of them might be the condition of things in a thunder cloud. Theory is very much at a disadvantage, because it is not at all clear what has to be explained, and it is, indeed, difficult to account for facts when we do not know what are the facts to be accounted for.

Dr. Hann has suggested, very properly, that the effect of shooting upon a winter fog should be ascertained. There appears to be some evidence that gun-firing clears the air of such a fog. But whether theory is to regard the noise or the smoke or the energy of the vortex ring as the cause of the effect, or whether, indeed, there is any effect to be explained, is not yet finally established. At the same time, no one is prepared to say that no effect is possible or is willing to lay claim to sufficient knowledge of the conditions of the atmosphere immediately preceding a hailstorm to venture any categorical opinion on the various theories. The subject was brought before the conference of meteorologists last year at Paris by several writers, and some additional information about it will doubtless appear in the report of that conference when it is published; in the meantime, the prominent meteorologists of the countries where there is a great popular demand for weather shooting, Styria, Hungary, Italy, Switzerland and France, are unanimous in the desire that the demand may lead to definite investigation of the nature of the processes taking place in thunderstorms, and especially in the formation of hail, which will lead to a real advance in our knowledge of these phenomena and will furnish a satisfactory basis for a theory of weather shooting. W. N. SHAW.

VIRIAMU JONES.

YET another gap in the front rank of science. But yesterday it was Fitzgerald, then Rowland, and now—Viriamu Jones is dead, the last, like the first, especially great in inspiring others.

Son of a working collier, a collier with rare gifts, the "poet-preacher" of Wales who thrilled with his silver tongue the gathered thousands and moved the multitude with his mighty eloquence, Viriamu inherited all those qualities which tend to greatness and came into daily contact with them in his own home. His very name indicated what was expected of him, for "Viriamu" was the name of the martyr missionary Williams, rendered as best it could be by the Polynesian tongue.

At the earliest permissible age of sixteen, Jones passed the London matriculation examination and won the scholarship in geology, the subject in which he took his degree with first-class honours three years later. Meanwhile he was gaining prizes, medals and scholarships at University College, London, and was elected Brackenbury scholar at Balliol College, Oxford. Going there at the age of twenty, he came under the direct influence of Jowett and commenced that personal friendship which influenced his whole life. After obtaining a first class in mathematical moderations in the final school of mathematics and in the final natural science school, he was elected principal and professor of mathematics and physics in the Firth College, Sheffield, when only twenty-five.

How he used to laugh because he always knew exactly what an examiner wanted; and what a true estimate did he form of the poverty of the examination system to test a man's real powers. How sympathetic was he when one was despondent at the unpractical character of the "intellectual miser," the student who spends his time acquiring and hoarding knowledge without giving the world a single new idea of his own. His views on education were of the broadest; to him the study of Greek and Latin, a problem in mathematics, the adjustment of a Whitworth measuring machine, were all equally living, and in the niceties of all three he showed the same absorbing interest.

No wonder, then, that when the first principal of the University College of South Wales had to be appointed the council chose the youngest of the thirty applicants —for that youngest was Jones in his twenty-seventh year. And no appointment ever made was better justified. The many speeches to his memory, the letters that have flowed in from every side, including one from the King, all prove how the work of the principal was appreciated, how the man was idolised.

He placed the University College system of Wales on a truly educational and democratic basis, and shaped the educational policy of his country by formulating the system of secondary education, which fills the gap between the primary schools and the colleges, and by the part he played in establishing a University for Wales.

The charm of his personality, his magic smile, the grace of his diction and his winning persuasiveness secured success where others could but court failure. Some 70,000*l.* he gathered together for the building of the new college, but a free site was still wanting, for this had been refused by the Corporation last summer, when Jones was too ill to be in England. Returning, however, in the autumn, he sought an interview, as a belated member of the deputation, charmed the Corporation into reversing their decision, and won for his college a site as a free gift. Well might Sir William Harcourt, when Chancellor of the Exchequer, jocularly say that Principal Jones was the cleverest beggar he had ever met with, and about the only one he could not get rid of without promising to give what was asked for.

Deep is the gratitude the college feels for its first principal; sincere is the praise Wales is reverently showering on the young first Vice-Chancellor of its University.

During the last few years I saw much of Viriamu Jones in connection with the construction of electrical standards, and I was always struck with surprise at the way in which one who found his greatest relaxation in studying the poetry of the most regular and attentive of his father's congregation—Robert Browning —discussed in detail why he thought the physical theories of the day too fanciful, and criticised the modern electrical measuring instruments for not being constructed on engineering lines.

His immediate ambition was to provide the National Physical Laboratory with electrical standards constructed like well-designed engineering machine tools rather than the ordinary physical laboratory apparatus, and it was towards such an end that his scientific work of recent years tended. A certain City company had promised him the funds for a far more perfect Lorenz apparatus than any yet made, and many were our talks about its details, how the coil and rotating disc were to be horizontal, and the non-magnetic driver a turbine, &c.

His first paper on this particular subject of electrical standards was published in 1888, and consisted of a determination of the coefficient of mutual induction of a circle and coaxial helix in connection with constructing the coil of a Lorenz apparatus by winding a *single* layer of wire in a screw thread cut on the surface of a large brass cylinder. For it seemed probable that with such a coil Lord Rayleigh's formula, which is a first approximation, would not give a result of sufficient accuracy, and Jones succeeded by a method of direct integration in obtaining a comparatively simple formula which gave the coefficient of mutual induction with greater accuracy, and enabled a single larger coil, the geometry of which can be better known than one of many convolutions, to be employed. In the following year he discussed the employment of Lissajous' figures for determining the rate of rotation of the disc of the Lorenz apparatus and of a Morse receiver for measuring the periodic time of the tuning-fork employed.

In 1890 he announced, at the meeting of the British Association at Leeds, that with the use of his specially constructed Lorenz apparatus the ohm was equal to the resistance of 106·307 centimetres of mercury one square millimetre in cross-section at 0° C., the complete account of the apparatus, its use, the mathematical calculations employed and the results obtained being published in the *Philosophical Transactions* of the Royal Society for 1891. Three years later he was elected a Fellow of that Society.

Appendix iii. of the 1893 Report of the British Association Committee on electrical standards consists of the results of his use of the Lorenz apparatus to measure directly the value of commercial low resistances of the order of 1/5000th of an ohm with an accuracy of one part in 12,000, as contrasted with the comparison of such resistances with a known standard in the ordinary ways. Appendix ii. of the 1894 Report deals with a determination of the ohm by measuring the absolute value of the resistances of a combination of four coils which had been compared with the standards of resistance in the Cavendish Laboratory; while in Appendix ii.

of the 1897 Report is a full description of the use of a Lorenz apparatus (constructed to Jones's designs for the McGill University) in determining the absolute values of the same four coils. From this it followed that a Board of Trade ohm equalled 1·00026 true ohms.

In the interim—viz. in 1896—he gave an account of the correction that would have to be made in consequence of a very slight ellipticity of his large brass coil, which he found to exist in 1894, and he showed that his 1900 value of 106·307 centimetres for the ohm would have to be increased to 106·319 on this account.

The formula developed by him in 1888 for the calculation of the mutual induction of a circle and a coaxial helix, although comparatively simple, in view of the accuracy obtained with its use, led, in reality, to a long laborious calculation when employed in practice. Consequently he spent some of the leisure of his voyage home from Montreal in 1897 in working out a simplification of the method previously described and a more general solution. And the account of this formed the substance of the paper he read before the Royal Society in November of that year.

Jones' ampere balance, briefly described in Appendix iii. of the 1898 British Association Report, was designed of a form which would readily lend itself to the use of a new formula (also developed in the preceding Royal Society paper) for the force between a uniform cylindrical current sheet and a coaxial helix, which could be readily expressed in elliptic integrals.

The liberality of the British Association, and of Sir Andrew Noble, will enable his standard ampere balance to be realised. The love of his friend will accomplish its completion.

Through Cardiff's hushed streets, contrasting strangely with their noisy traffic of other Saturdays, the long procession, last week, wended its way. Bright was the van with the mounted escort and the firemen's glittering helmets, sombre the rear with the girl students in their caps and gowns. By his father's side, high up on the hill overlooking Swansea Bay, we laid him—the man of high ideals, the man who had lived a long long life though dead at the age of forty-five. W. E. AYRTON.

It was right that one who did so much for the educational advancement of Wales should be given a public funeral. A memorial service was held at the Park Hall, Cardiff, on Saturday morning; the Bishop of Llandaff read the lessons, while the sermon was preached by the Rev. J. Williamson. After the service there was a procession to the Great Western Railway Station, and the gathering included representatives of important municipal and public bodies, the University of Wales, the University colleges of Wales and other educational authorities and institutions. A special train conveyed the body and the mourners to Swansea, where the interment took place, the Mayor of Swansea and the members of the Corporation, as well as representatives of local educational bodies, taking part in the mournful ceremony.

NOTES.

THE Royal Society announces that it is about to make the first award of the Mackinnon research studentship. The studentship is founded under a bequest to the Royal Society by the late Sir William Mackinnon, Director-General of the Medical Department of the Army, of the residue of his estate upon trust to be applied for the foundation and endowment of such prizes or scholarships for the special purpose of furthering natural and physical science, including geology and astronomy, and of furthering original research and investigation in pathology as the Society may think best and most conducive to the promotion of those sciences and of original discoveries therein. The committee appointed by the council of the Royal Society to advise upon the best mode of giving effect to the intentions of the testator recommended that the award should be in the nature of a studentship for the encouragement of research rather than a prize for the reward of past achievements, and that the studentship should be devoted to the maintenance of a student engaged in such researches as were indicated by the testator. The studentship will be awarded this year in one of the biological sciences, including physiology and anatomy, pathology, botany, palæontology and zoology; it will be awarded for one year, but will be renewable for a second year. The studentship is at present of the annual value of 150*l*., but the awards may be multiplied in future, upon the determination of certain outstanding charges upon the property. Applications must be received not later than June 26 by the assistant secretary of the Royal Society, from whom further particulars may be obtained.

THE gold medal presented biennially by the Pharmaceutical Society in memory of Daniel Hanbury, for high excellence in the prosecution or promotion of research in connection with the chemistry and natural history of drugs, has this year been awarded to Dr. George Watt, reporter on economic products to the Government of India. Dr. Watt, says the *Pharmaceutical Journal*, was born at Old Meldrum, Aberdeenshire, on April 24, 1851, and was educated at the Grammar School, King's College, and Marischal College, Aberdeen, subsequently graduating as M.B., with first-class honours, in the University of Glasgow. He became assistant professor of botany at Aberdeen in 1871, and professor of botany at Calcutta University in 1873. His best-known work is the "Dictionary of the Economic Products of India," but he is also editor of the *Agricultural Ledger*, and of the report of the Central Indigenous Drugs Committee of India for 1900, as well as the author of reports on the pests and blights of the tea plant, on rhea and China grass, on lac and the lac industries of India, and on a plague in the betti-nut palms of India. He has also published a "Flora of Chamba," a monograph on the Primulaceæ, and other scientific and technical works. Dr. Watt is still engaged in clearing up the difficulties that surround the botanical sources of aconite roots of Indian commerce, and has only recently furnished material for the investigation of kino.

THE conditions which will control the administration of Mr. Carnegie's munificent gift to Scottish Universities have now been published, and they remove the difficulties which presented themselves when the announcement of the donation was made, but no particulars were available as to its allocation. The annual income from the trust is estimated at 104,000*l*., and it is to be administered by an executive committee of nine members, the first committee being constituted as follows:—The Earl of Elgin, who is to act as chairman, Lord Balfour of Burleigh, Lord Kinnear, Sir Henry E. Roscoe, Mr. Shaw, the Lord Provost of Edinburgh, the Lord Provost of Glasgow. Two remaining members are to be two of four trustees nominated by the University Courts, the members for Edinburgh and Aberdeen acting during the first two years, and the members for Glasgow and St. Andrews acting during the second two years. One-half of the net annual income is to be applied towards the improvement and expansion of the Universities of Scotland in the faculties of science and medicine, also for improving and extending the opportunities for scientific study and research, and for increasing the facilities for acquiring a knowledge of history, economics, English literature and modern languages, and such other subjects cognate to a technical or commercial education as can be brought within the scope of the University curriculum. The other half of the income, or such part thereof as in each year may be found requisite, is to be devoted to the payment of the whole or part of the ordinary class fees exigible by the Universities from students of Scottish birth or extraction and of sixteen years of age and upwards, or scholars who have given two years' attendance after the age of fourteen years at State-aided schools in Scotland, or at such other schools and institutions in Scotland as are under the inspection of the Scotch Education Department. Any surplus remaining in any year from the income applicable to this head of expenditure is to be applied to the first head of expenditure. In the case of schools or institutions in Scotland established to provide technical or commercial education, the committee may recognise classes which, though outside the present range of the University curriculum, can be accepted as doing work of a University level, and may allow them and the students thereof to participate under both heads of the trust deed. The benefit of the trust is to be available to students of both sexes. The trustees are to have full power, by a majority of two-thirds of their number, to modify the conditions under which the funds may be applied so as to secure that these shall always be applied in the manner best adapted to meet the purposes of the donor as is expressed in the constitution, according to the changed conditions of the time.

THE new Pathological Institute at the London Hospital will be formally opened by Sir Henry Roscoe, vice-chancellor of the University of London, on Wednesday, July 10, at 3 o'clock.

THE American Chemical Society has elected the following honorary members:—Prof. W. Ramsay, Sir Henry E. Roscoe, Prof. E. Fischer, Berlin, Prof. A. Baeyer, Munich, and Prof. G. Lunge, Zurich.

THE gentlemen selected by the council of the Royal Society for admission as Fellows this year were elected at the meeting held last week. The qualifications of the new Fellows were given in NATURE of May 9 (p. 36).

THE sixty-ninth annual meeting of the British Medical Association will be held at Cheltenham on July 30—August 2. The president-elect is Dr. G. B. Ferguson. An address in medicine will be delivered by Dr. J. F. Goodhart and an address in surgery by Sir William Thomson. The scientific business of the meeting will be conducted in thirteen sections.

THE establishment of a Ministry of Commerce, under a minister of business experience, is being actively urged by the *Daily Express*. A provisional committee has been formed, consisting of a large number of Members of Parliament, civic authorities, presidents of Chambers of Commerce, and heads of important business firms. It is proposed to hold a public meeting in London at an early date, with the object of forming an association and generally to take practical steps in the organisation of the movement.

THE Paris correspondent of the *Times* announces that M. Th. Ribot, professor of experimental psychology at the Collége de France, the founder of the *Revue Philosophique* and the inspirer of an entire generation of students and professor of the new psychology, not only in France but all over the world, will retire on a pension, at his own request, at the beginning of November.

WE are informed that, in the unavoidable absence of the president of the Institution of Electrical Engineers, Mr. Alexander Siemens (past president) will, at the unanimous request of the council, assume the leadership of the Institution party throughout the visit to Germany. Members are reminded that their applications for tickets should be forwarded before Saturday next, June 15.

ACCORDING to the latest returns the population of Paris increased during the last five years by 6·98 per cent. At the last census, which was taken at the end of March 1896, the inhabitants numbered 2,536,834; but at the present time the total is 2,714,068.

AT the annual meeting of the Akademie der Wissenschaften, of Vienna, on June 1, it was announced that Prof. Eduard Suess had been unanimously re-elected president for a further period of three years. Thereupon the Professor delivered his presidential address, which contained, amongst other scientific statements, some valuable references concerning the life and works of the late Prof. Max Müller, of Oxford, who for many years was honorary member of the Akademie. Prof. Berthelot, of Paris, was nominated honorary member, and the following gentlemen were elected as foreign corresponding members:—Profs. Schlegel (Leyden), Oppert (Paris), Linde (Munich), Retzius (Stockholm), Kowalesky (St. Petersburg).

BY the courtesy of the editor of the *Chemist and Druggist* we are able to give an illustration of the monument to Pasteur, shortly to be erected at Dôle, where he was born. The statue,

Monument to Pasteur, to be erected at Dôle.

the sculptor of which is M. Antonin Carles, is in bronze, and stands on a pedestal eight metres high. The figures at the base of the monument represent Humanity bringing two children to Pasteur, while Science offers him a palm.

THE *Electrician* announces that the system of etheric signalling devised by Sir William Preece has been successfully installed for the purpose of placing Rathlin Island in telegraphic communication with Ballycastle. The distance over which the signals are transmitted is about ten miles, as the waves go, and the lengths of inductive wire employed on each side are one and six miles respectively, the shorter length being on the island. The telephone was used as the receiver, with Morse signals transmitted by means of a "buzzer"—a more rapid if less sensitive arrangement than the Marconi coherer.

REFERRING to the death of the ethnologist Dr. Arthur Hazelius, on May 27, in his sixty-eighth year, the *Athenaeum* says he was the founder of the Ethnographical Nordische Museum and of the unique and interesting Skansen, the open-air museum in the Zoological Garden of Stockholm, the result of nearly thirty years of labour, where the national life of old

Sweden is represented in vivid fashion, not merely by means of buildings, but also by the festivals and music of earlier times. Dr. Hazelius's son has, it is stated, been elected to succeed him as director of the Nordische Museum.

THE death is announced of Mr. William Walton at Little Shelford, near Cambridge. He was born in 1813 and graduated as a member of Trinity College in the mathematical tripos of 1836, being eighth wrangler. After taking his degree he remained at Cambridge and became a successful private tutor and lecturer in mathematics. He published a considerable number of mathematical treatises which for many years were used as text-books by students. His chief works were a treatise in illustration of the principles of theoretical mechanics and a volume on the differential calculus.

AN International Fire Prevention Congress met at Berlin last week, under the presidency of Count Komarowsky. The first resolution, which was unanimously carried, was proposed by Mr. Edwin O. Sachs, and was in the following terms: (1) That the serious investigation of the fire resistance of materials and systems of construction should be supported both by the Government and local authorities, as well as by those technical societies to whose members the results of such investigations are important in the practice of their professions. (2) In view of the fact that identical materials and systems of construction are frequently employed in different countries, an effort should be made to standardise the results obtained from fire tests in such a manner that the investigations made in different countries should be compared in a practical manner with due regard to units of measurement and temperature.

WE regret to see the announcement in the *Times* of the death of Prof. Bleicher, director of the school of pharmacy in the University of Nancy, and formerly professor of natural history at the same school. He was shot by a pharmacist from whom a sample of cinchona had been seized for analysis at the school. This crime has deprived France of one of the scholars who have done most to reveal to the world the geological interest of the frontier provinces of France. Prof. Bleicher's "Les Vosges, Le Sol, et Ses Habitants" is a classical treatise which every traveller in Alsace-Lorraine should always carry with him. Every year Prof. Bleicher spent his holidays on one or other of the slopes of the Vosges, studying the stratifications, the rocks, the glacial marks, all the features, in a word, of this interesting region, upon which he had published a large number of memoirs. He had begun life as Médecin-Major in the French African army, but left his work there in 1877 to become professor at Nancy, where he was very popular, often conducting students' scientific expeditions.

THE scientific study of plant associations and conditions of growth of crops was urged by Mr. R. Hedger Wallace in a lecture delivered at the museum of the Royal Botanic Society on Friday last, Sir George Kekewich, K.C.B., being in the chair. He remarked that commercial crop cultivation as a subject correlated the practical details taught by economic geography and botany. The mapping of plant associations would be of service, because wherever a man wishes to cultivate the ground a study of its actual flora is the most trustworthy guide to the possibilities of success or failure of new species. To the agriculturist and horticulturist the characteristics of plant areas are better guides than those of climate alone, because in plant distribution the influence of soil and drainage is correlated with that of climate. What are needed, the lecturer stated, are maps showing natural plant areas, cultivated crop areas and zones of cultivation, distinguished by definite colours like a geological map. With respect to plant distribution and zones of cultivation, attention was directed to the work that has been done in Germany, especially by Profs. Oscar Drude and Engelbrecht. The botanist who studies the distribution of plants usually eliminates all consideration of the plants that are cultivated by man as vitiating his inquiry. Engelbrecht, on the other hand, deals entirely with the distribution of cultivated plants, though his survey is restricted to agricultural and horticultural produce grown outside the tropics. To study the commercial crop cultivation of a country the geographical conditions should be noted. Land forms, that is, the relief of the land, have a powerful influence, indirectly as well as directly, on plants, animals and human beings. An endeavour should therefore be made to gain some idea of what might be termed the climatic control of land forms, and the influence of land forms on natural flora and cultivated crops.

WITH reference to the inquiry of a correspondent as to the appearance of the Hoopoe on Lundy Island (p. 132), Mr. W. H. Graham writes from Fowey, Cornwall, "I dare say your correspondent would be interested to know that I saw a Hoopoe here in 1900, and one has been seen here this year; both were seen in the early spring, March, I think. Possibly those on Lundy Island have crossed from Cornwall."

THE invention of the Poulsen telegraphone, a full description of which in its latest form we hope shortly to publish, seems to have stimulated efforts to replace the wax cylinder phonograph by some more satisfactory arrangement. Descriptions of two new phonographs have quite recently been published—one the invention of Prof. Nernst and R. von Lieben, and the other invented by E. Ruhmer. A full account of Prof. Nernst's arrangement appears in the *Electrician* for June 7. The principle of which he makes use is the alteration of polarisation capacity and surface resistance of a metal used as an electrode in an electrolytic bath. A copper disc about 3 mm. thick is rotated at a fairly high speed, whilst there presses against its edge a thin wedge of wood soaked in an electrolyte. The secondary currents from the induction coil of a microphone transmitter are caused to pass through this contact and leave a record on the edge of the disc on account of the varying amount of chemical change produced. A telephone receiver is then substituted for the microphone, a battery being included in the circuit, and on again rotating the disc a reproduction of the sound is obtained. The best results seem to have been given by a solution of potassium zincate, using the edge of the copper disc as kathode, the wedge standing in a bath of the solution into which a zinc anode dips. With this, it is stated, the sounds can be reproduced clearly and distinctly two or three hundred times. The record can be cleaned off with fine emery paper.

RUHMER'S phonograph is based on an entirely different principle, thus making the third new phonographic method worked out in the past few months. The information at present at hand is, however, very scanty, so that we cannot do more than state the general claims of the inventor. Herr Ruhmer photographs, on a moving film, a sensitive flame which is being affected by sound vibrations, and thus obtains on the film a band of varying intensity; light is then projected through this band on to a selenium cell which is included in circuit with a battery and telephone. The variations in intensity as the film is passed before the source of light cause variations in current in the telephone circuit which reproduce the original sounds. The reproduction, it is said, is clearer than in the Poulsen telegraphone, and as an additional advantage multiplication of the records can be carried out photographically to any desired extent.

DURING the last few years the Danish Meteorological Institute has issued a very useful volume entitled "Nautical-Meteorological Annual." That for the year 1900 has just appeared and contains a summary of the state of the ice in the Arctic seas for each of the months March to August, with maps. Generally speaking, there were considerable masses of ice during the season 1900 in the north-west of Barents Sea, around Spitzbergen and in the Kara Sea, less than usual between Franz Joseph Land and Nova Zembla and on the east coast of Greenland, while in Baffin Bay and near Labrador the conditions were particularly favourable. The volume also contains tables showing the diurnal amplitude of the air at the various Danish light-vessels, and the surface temperature of the sea in the northern Atlantic Ocean and Davis Strait. The greater part of the work is taken up by carefully compiled tables of general meteorological observations, taken every four hours by the light-keepers, together with monthly means. These form a valuable contribution to the meteorological statistics of the northern parts of Europe.

M. D. KORDA announces in the *Bulletin* of the French Physical Society that in a fraction of a minute he has succeeded in crystallising ferrosilicium in the bottom of a crucible by cooling with water. The form of the crystals varies with the proportion of silicon—long needles for 10 to 100 of silicon (Fe_2Si), tetrahedra of 1 to 10 mm. length of side for 22 to 23 per cent. of silicon (FeSi), and laminæ of micaceous character for 50 per cent. of silicon ($FeSi_2$). Crystals of ferromanganese or ferrochromium can be similarly formed.

DR. EMILIO ODDONE describes, in the *Rendiconto* of the Lombardy Institution, experiments conducted for the purpose of determining the mean coefficient of transparency of the air over distances considerably greater than those previously experimented on, and he gives examples of the application of this method to distances of 45, 85 and 135 kilometres. The coefficients are fairly high, increasing with the distance, and the ultimate values are only slightly less than those corresponding to vertical vision. From this property, Dr. Oddone thinks it possible to calculate approximately the thickness of the atmosphere in the direction of the zenith.

THE *Archives* of the Röntgen Ray contains a short programme of the Röntgen Exhibition to be held in Hamburg in connection with the seventy-third meeting of the Deutscher Naturforscher und Aerzte. The scientific part will be in the hands of Dr. Albers-Schönberg, Dr. Walter and Dr. Hahn, while the literary part will be taken by Messrs. Lucas Gräfe and Sillem. The physical section will include induction coils and contact breakers, portable apparatus, tubes, fluorescent screens, operating tables, stereoscopes and other accessories, power for working the coils, &c., being obtainable at 220 volts continuous and 120 volts alternating current. The medical section will exhibit the latest achievements in radiography and the therapeutic uses of Röntgen rays. In addition with the above it is mentioned that at a recent sitting of the Prussian Kultus Ministerium the Universities received a grant of 1000*l.* for additions to the Röntgen ray departments.

UNDER the title "A New Era in Interior Lighting," Mr. Charles L. Norton writes in the *Technology Quarterly* advocating the use of ribbed, corrugated and prismatic glass windows for diffusing light in the interior of rooms and offices. The only comment we can make is that as modern civilisation compels men to work in dingy offices and factories it has been necessary for modern civilisation to devise some means of lessening their dinginess, then "adaptation to environment" will come in and give us a civilised race which actually prefers this kind of illumination to that of the good old plate glass window. Of this tendency Mr. Norton himself affords an instance when he expresses the view that it is to be *regretted*, but it is certainly true, that strong objection is often made to the "shut in" feeling which some people experience in rooms glazed wholly with diffusing glass. He also considers it one of the uses of the diffusing window that it allows of the closer approach to one another of tall buildings, with a resulting economy of land—and, we should say, an aggravation of the unnatural conditions under which human life maintains its unlovely struggle for existence in densely populated centres.

IT is interesting to notice how the naval architect is becoming more and more dependent on a knowledge of applied mathematics and mathematical physics for the solution of the problems involved in perfecting the construction of steamships. It is only recently that the balancing of marine engines has received serious attention, and this problem has brought the principles of rigid dynamics as well as Fourier's series under the notice of the shipbuilder. But when the parts of an engine have been balanced on the hypothesis that they are perfectly rigid there still remain the effects of their elasticity to be taken into account. Mr. J. H. MacAlpine has recently communicated to the *Journal* of the American Society of Naval Engineers a monograph of 288 pages on "Inertia Stresses of Elastic Gears." The investigation seems to have been suggested, in the first instance, by the defective working of certain forms of valve gear. While Mr. MacAlpine hardly thinks that the elaborate processes of calculation which he gives can be frequently repeated in the ordinary course of designing, they might, at least partly, be resorted to with advantage and with but little labour, in cases where the effect of elasticity seems doubtful. Their application would have saved many expensive breakdowns in the past, and if applied to such cases as the *Newark*, where serious trouble has arisen, would gradually accumulate a store of valuable data which could not fail to be useful.

IF we may judge by the Report of the Marlborough College Natural History Society for 1900, the issue of the Victoria series of County Histories is having a good effect on institutions of this nature in calling attention to the incompleteness of their records of local faunas. In this particular instance, the local lists of the popular groups of Hymenoptera, Lepidoptera and Coleoptera were found to be well worked up, but those of other groups of insects had been much neglected. The editor also calls attention to the advisability of schoolboys confining their attention to a single section of zoology; otherwise, with the multitude of other studies and occupations, any real progress is impossible.

WE regret to learn, from a communication by Mr. A. J. North to the Records of the Australian Museum for 1901, that the destruction of native birds in New South Wales is attaining alarming proportions. After referring to a recent newspaper article containing an account of the slaughter of about 250 lyre-birds by one man during a single season, the author dwells on the injury done to bird-life in Australia by the growth of the great cities and their suburbs and the consequent clearance of timber and coppices. In Sydney the diminution in the number of indigenous birds owing to this cause is bad enough, but it is nothing to what has occurred in Melbourne, which is virtually denuded of trees for miles around. But this is by no means all, for the introduction of foreign mammals has played havoc with many kinds of native birds. Now that the rabbits have been eradicated in many districts the cats introduced to prey upon them have turned their attention to the birds; and the introduced foxes, in addition to robbing hen-yards, destroy hosts of indigenous birds. Neither can the sparrow and the starling be exonerated from blame in the matter. Mr. North urges the necessity of the duty of bird-protection being taught in the schools, as in the United States.

THE significance of spiral swimming—that is to say revolution on their own longer axis—by many of the lower organisms, such as the ciliate and flagellate infusorians and volvox, is discussed by Dr. H. S. Jennings in the May issue of the *American Naturalist.*

The function is considered to be of considerable importance. It has been found that the same side of the organism is always directed towards the outer side of the spiral. In the case of spherical organisms like volvox the spiral movement probably serves merely to correct any accidental deviations from a straight course; but without this device many creatures would be quite unable to steer straight, and many of them would merely describe circles without making any forward progress at all. "The simple device of revolving in the axis of progression is surprisingly effective, in that it compensates with absolute precision for any tendency, or combination of tendencies, to deviate from a straight course in any direction."

We have received three specimen numbers of a popular Danish illustrated weekly magazine called *Frem* (Forwards), and devoted to ancient and modern history, archæology, literature and science. The outer portions of the paper are in quarto, but the inner portion, when cut up, consists of an octavo sheet, containing four pages each of various independent works. The parts before us, published in September and October, 1900, include parts of a novel; a translation of Shakespeare's "Henry IV."; a work on ancient history by Johan Ottosen, with illustrations of buildings, a cross, &c.; and a work by Levyson on the human body, with numerous text illustrations, and coloured diagrams of the organs of the upper part of the body and of the heart. The quarto contents of the parts are equally varied, and among them we notice articles and illustrations relating to the tortoises of the Orinoco, a Khirghis mother and children, edible and poisonous fungi, runes, old buildings, gout, the Moloch lizard, the Franco-German war, China, and the Transvaal, &c. It is one of the most miscellaneous publications which have come under our notice, in some respects resembling the old *Penny Magazine* of sixty years ago. *Apropos* of Shakespeare, we may mention that the plays are being translated into Finnish; and seventeen have already been published by the Finnish Literary Society at Helsingfors.

Contorted Beds at Jangye-Ryn, Gunwalloe.

The *Journal of Botany* for June gives the more interesting notes contained in the Botanical Exchange Club Report for 1899, which is now edited by the Rev. W. R. Linton.

Mr. F. N. Williams has issued a specimen of a "Prodromus Floræ Britannicæ," in which an attempt is made to epitomise the distinguishing characters of all British species and subspecies of plants, the descriptions being given in Latin, "the nominative absolute style with separate sentences."

The Royal Geological Society of Cornwall has lately issued its eighty-seventh Annual Report, together with the papers read during the session 1889–1890 (*Transactions*, vol. xii. part 6). Mr. J. B. Hill, who is engaged on the Geological Survey, has brought the experience which he gained in Argyllshire to bear on the slaty rocks of Cornwall. He finds the structures there to be identical with those of crystalline schists, but the mineralisation is wanting. In the Falmouth district the strata have been thrown into a series of isoclinal folds accompanied by small faults, and further minor structures have been set up until the mass has become full of minute folds and thrusts. These disturbances have in some cases caused, not only severing and brecciation of the bands, but also the rounding of fragments so as to produce "crush-conglomerates." The author remarks that had the rocks been subjected to these stresses at a greater depth and below the zone of fracture, where they would not have been so free to move, they would have been converted into true schists. Mr. Howard Fox gives a brief description of the remarkable contorted beds of Gunwalloe, in the Lizard district near Helston, together with an excellent photographic plate (which we reproduce by permission of the Society). The thick pale bands are grits, the thin dark bands are much squeezed shales, and there are numerous quartz and calcite veins. The beds appear to belong to the same group as the Ordovician cherts of Mullion Island. In an article on the sequence of the Lizard Rocks, Mr. Harford J. Lowe brings forward evidence to show that the granulitic series is later than, and instrusive in, the serpentine.

We have received the first number of a new botanical journal, to be issued at irregular intervals, *Biltmore Botanical Studies*, embracing papers by the director and associates of the Biltmore Herbarium, North Carolina. The present number is occupied by five papers on descriptive phanerogamic botany.

In a new edition of "Modern Cremation," which has just been published by Messrs. Smith, Elder and Co., Sir Henry

Thompson adds some important matter to the previous edition, and brings the history of the practice of modern cremation up to the present time. The case for cremation or some method of disposing of the dead other than burial is given much support by the evidence described in this book. The practical details given in an Appendix will be of service to people seeking information upon the subject.

MESSRS. DULAU AND CO. have sent us a copy of their various catalogues of zoological and palæontological books and pamphlets issued between 1896 and 1901. These, which are arranged in subjects, have been bound together into one volume, which will be found of considerable use to the working naturalist as a guide to much of the literature of any subject on which he may be engaged.

A NEW edition, revised and enlarged, of Prof. W. C. Unwin's "Elements of Machine Design" (Part 1) has just been published by Messrs. Longmans, Green and Co. The plan and general arrangement of the book remain the same as the original, published many years ago, but about a hundred pages have been added and numerous alterations have been made.

A NEW edition of "Telephone Lines and their Properties," by Prof. W. J. Hopkins, has been published by Messrs. Longmans, Green and Co. Among the additions are an account of the latest developments in the design of long lines, a chapter on "composite" working and wireless telephony, an abstract of Dr. Pupin's paper on telephony over cables and long-distance air lines, and a paper on inductive disturbances in telephone circuits.

RECENT numbers of American geographical journals contain much information about Alaska. In the May issue of the *National Geographic Magazine* Mr. Henry Gannett publishes an article on the general geography of Alaska. The second number of *Mazama* is devoted almost entirely to Alaska; it includes an account of the Harriman Alaska Expedition and a reproduction and explanation of an Indian map from the Chilkaht to the Yukon. *Mazama* also contains a paper on the flora of Mount Rainier, by Prof. C. V. Piper.

THE value of "The Statesman's Year Book" (Macmillan and Co., Ltd.) can only be rightly appreciated by those who keep the annual at hand for ready reference. The edition for 1901 has now appeared, and Dr. Scott Keltie and his colleague, Mr. Renwick, are again to be congratulated upon its publication. The work is an epitome of political geography, containing the essential particulars concerning the constitution, communications and commerce of every country in the world. The changes of the past year have necessitated the revision of several parts of the book. The Transvaal and the Orange Free State are now included in the section on the British Empire, and the Australian Commonwealth is described. The results of the censuses taken during last year and the early part of this are also given. There are five maps, the first giving a comparative view of geographical knowledge and political divisions in 1800 and 1900, and the second showing the political partition of Europe in the same years. The other maps represent railways, navigable waters and steamship routes in North America, South America and Australia. The volume now extends to 1320 pages, and ought not to be much further increased in size or it will lose its present handy character.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂) from South Africa, presented by Mr. Geo. Blay; a Rhesus Monkey (*Macacus rhesus*) from India, presented by the Hon. Mrs. Morrison; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Colonel B. McCalmont; a Pin-tailed Whydah Bird (*Vidua principalis*) from West Africa, presented by the Hon. Mrs. Parker; two Ocellated Sand Skinks (*Chalcides ocellatus*), South European, presented by Mr. W. H. St. Quintin; two Common Vipers (*Vipera berus*), British, presented respectively by Mr. Gerald Leighton and Mr. John Wright; a White-collared Mangabey (*Cercocebus collaris*), two Yellow Baboons (*Cynocephalus babouin*) from West Africa, a Yellowish Capuchin (*Cebus flavescens*), a Brazilian Tortoise (*Testudo tabulata*) from South America, a Silky Marmoset (*Midas chrysoleucos*) from Rio Madeira, Brazil; two Pinche Monkeys (*Midas oedipus*) from Colombia, a Three-banded Douroucouli (*Nyctipithecus trivigatus*) from Guiana, three Serrated Terrapins (*Chrysemys scripta*) from North America, two Black Tortoises (*Testudo nigra*) from the Galapagos, a Black Iguana (*Metopoceros cornutus*) from the West Indies, a Common Chameleon (*Chamaeleon vulgaris*), a Basilisk Chameleon (*Chamaeleon basiliscus*, from North Africa, a Blue-tongued Cyclodus (*Tiliqua scincoides*), thirteen Black and Yellow Cyclodus (*Tiliqua nigro-luteus*) from Australia, four Green Lizards (*Lacerta viridis*), three Dark Green Snakes (*Zamenis gemonensis*), three Tessellated Snakes (*Tropidonotus tessellatus*), two Æsculapian Snakes (*Coluber longissimus*), a Four-lined Snake (*Coluber quatuorlineatus*), European; a Chained Snake (*Coluber catenifer*) from California, deposited; a Red Deer (*Cervus elaphus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

TWO NEW VARIABLE STARS.—Prof. W. Ceraski announces in the *Astronomische Nachrichten* (Bd. 155, No. 3718) the discovery of two new variables at the Moscow Observatory. The measures were obtained from photographs.

72, 1901 (Lyræ).

R.A. h. m. s.		Decl. ° ′ ″		
19 7 37·01	...	+33 10 12·6	...	1855·0
19 9 17·62	...	+33 14 38·1	...	1900·0

The brightness varies from the 10th to 12th magnitude, in a period of from 0·27–0·81 of a year. At present it is about the 11th magnitude, and is increasing.

73, 1901 (Scuti).

R.A. h. m. s.		Decl. ° ′		
18 46 19·7	...	−12 46·9	...	1855·0

This variable is of the Algol type; normal magnitude about 9·0. Its period is about 22·9 hours, and its brightness varies from 9·1 to 9·6 in five hours. There appears to be evidence of two principal minima separated by a secondary one.

UNIFORM TRANSMISSION OF ASTRONOMICAL TELEGRAMS.—Prof. H. Kreutz, of the Central Astronomical Telegraph Bureau at Kiel, has issued a circular in several languages suggesting instructions for securing the adoption of a uniform system for the transmission of astronomical telegrams from the various observatories of Europe to the central bureau for subsequent general circulation.

The code suggested is very similar to that already in use for the telegrams which have been sent out from Kiel for several years past. A definite order is agreed on for the descriptive items of object, discoverer or observer, time, position, magnitude, motions and remarks, with a terminal number to control the accuracy of the numerical part of the message. In the circular issued examples of various possible forms of messages are given, both at length and in code, dealing with the discovery of comets or planets, new stars, orbits of comets, ephemerides, &c., perusal of which will easily make the scheme clear.

PHOTOGRAPHY OF CORONA.—In a reprint from a paper read before the Photographic Society of Philadelphia on March 13, 1900, Mr. H. W. Du Bois draws attention to the possibilities of the method, outlined by Prof. Nipher, of developing a positive from a plate which has received great over exposure, in connection with the problem of the daylight observation of the solar corona.

ELECTRO-MAGNETS.

IN this article it will be shown what a great advantage results from constructing electro-magnets on scientific principles, instead of making them according to everyday notions, and to give an idea which is the best form to adopt for producing very strong magnetic fields.

To understand the matter we must first consider the magnetic circuit, which is very analogous with the simple electric circuit. Just as when we have an electric current flowing in a copper rod, say, we know that the current is flowing round a complete circuit of which the rod forms only a part, so in the case of an iron rod magnetised by a current flowing round it, we consider that magnetism flows round a complete circuit of which the iron rod forms only a part. Fig. 1 is an ordinary bar electro-magnet; and in Fig. 2 B represents a cell and C A a copper rod the ends of which are joined by a great many thin wires of high resistance.

Now the flow of current in Fig. 2 is exactly analogous with the flow of magnetism in Fig. 1. The cell replaces the coil of

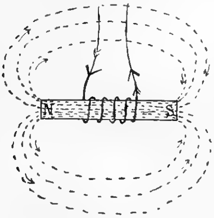


FIG. 1.

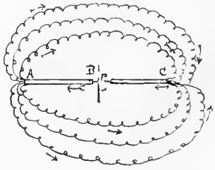


FIG. 2.

wire on the magnet, for whereas the cell sends the current in Fig. 2, the current flowing through the coil sends the magnetism in Fig. 1 through the iron rod, corresponding with the copper rod, and to complete the magnetic circuit the magnetism passes through the air in paths shown by the dotted lines, Fig. 1, back to the south pole of the magnet; so that the magnetic circuit in this case is formed partly of iron and partly of air.

The current flowing in the coils of wire on the magnet produces what is called a "magnetomotive force," which is proportional to the current and to the number of turns of wire; and a certain fraction of this quantity is used to send the magnetism through the iron rod and the remainder to send it through the air, or, in other words, every little piece of the magnetic circuit requires a certain magnetomotive force to drive the magnetism through it, and the sum of all these, taken all round the circuit, is the whole magnetomotive force due to the current in the coils; just as a certain part of the electromotive force of the cell is used to send the current through the copper rod and the remainder to send it through the thin wires forming the rest of the circuit. In fact, even the law governing the production of magnetism in a magnetic circuit is very similar to Ohm's law for the flow of current in an electric circuit, namely, that the amount of magnetism produced is equal to the magnetomotive force producing the magnetism, divided by the magnetic resistance, or "reluctance," as it is called, of the entire magnetic circuit. Hence, if the amount of magnetism is to be as large as possible it is just as important that the reluctance of the entire circuit should be small as it is that the current and number of turns of wire be large.

Now the reluctance of any little bit of a magnetic circuit, say from S to N, Fig. 1, for example, is proportional to the length of the piece, inversely proportional to its cross section, and also inversely proportional to the magnetic conductivity, called permeability, of the material. Therefore, to make the reluctance of our circuit small, we have to make: (1) its length small, (2) its cross section large, (3) and make it of a material whose permeability is as large as possible.

But the important thing is that the reluctance of the whole of the magnetic circuit must be small, not only of any particular part of it. For example, in Fig. 1, making the diameter of the iron bar large simply makes the reluctance of the circuit from S to N small, while the reluctance of the rest of the circuit, from N through the air to S is still very large, because the permeability of air is very small compared with that of iron. But if the bar is bent round into a ring, Fig. 3, then the reluctance of the whole circuit is reduced, and consequently a larger amount of magnetism will be produced in the bar for the same current flowing round it, and the density of the flow—that is, the strength of the magnetic field in the air space—will be very much increased.

There seems to be a popular idea that if a magnet is to produce as strong a field as possible it must be wound with an enormous number of turns of wire and a very large current sent round the coils, and that nothing else is of the least consequence. The following is a description of a large electro-magnet, made only about three years ago, which well illustrates this. It formed part of an electrical instrument intended to be used in connection with submarine telegraphy, the sole function of the magnet being to produce a very strong magnetic field. This result was certainly not obtained because it was not properly designed.

The magnet consists of two iron cores, 6 centimetres in diameter, each wound with about 1500 turns of wire, making the outside diameter more than 16 centimetres. To illustrate the

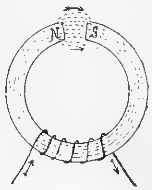


FIG. 3.

uselessness of this great amount of wire compared with the cross section of the iron, it has been found by experiment that if only one-third of the ordinary current is sent round the coils the strength of the magnetic field is thereby reduced only 15 per cent. If therefore the magnet had been wound with one-third the number of turns the cost of materials would have been about halved, and the power used to excite it only one-third, and even a less reduction than 15 per cent. in the strength of the field would have resulted.

The cross section of the piece of iron joining the two cores, *i.e.* "the yoke," is less than half that of the cores, and consequently the density of the flow of magnetism in the yoke is very large, and this means that the yoke will offer a great resistance to the magnetism for two reasons: (1) because the area is small, (2) Because the density being so large the permeability will be very small, for the magnetic conductivity gets rapidly less the greater the density; in fact, in this case the reluctance is so large that when the magnet is excited with its ordinary working current it produces a field of only 7900 C.G.S. units, and it can be calculated that the magnetomotive force used to send the magnetism through the yoke is then more than four times that required for the air gap, whereas in a properly designed magnet nearly all the magnetomotive force is used to send the magnetism through air gap and pole pieces. Doing what has been done here is exactly analogous with trying to send the strongest current that you can through an electrical apparatus by connecting to it the most powerful battery obtainable with two very long thin high-resistance wires. Analogy, therefore, shows us that the cross section of the yoke should have been made at least equal to that of the cores.

In order to see what sort of saving might have been effected, I have designed a magnet (Fig. 4) to produce the same effect as this one.

It consists of a cast steel ring, rectangular in section, the wire being wound on ten bobbins made of thin wrought iron, and not straight on the ring, for convenience in winding.

The design is made by starting with the assumption that a magnetic field exists of the strength desired in an air gap of the dimensions of the last magnet. Then the flow of magnetism at the section *a a*, Fig. 4, is calculated, ditto for section *b b*, where it is greater than at *a a*, by the amount which leaks out of the iron between these two sections. Similarly, the flow is obtained at all the sections, *c c*, *d d*, &c., round the circuit, the area of the iron at all these sections being made such that the density of flow has a value for which the magnetic conductivity of the cast steel is high. When the density of the flow is found, having a previous knowledge of the magnetic quality of the steel we can get the permeability for each section. Then the product of current, into number of turns of wire, necessary to force the magetism through all the different sections into which the magnetic circuit has been divided can be found, and, adding all these together, we can obtain the current that must be sent round the magnet a given number of times to produce the desired effect. The following table gives the flow, density of flow, &c., at the different sections (Fig. 4), the "ampere turns," *i.e.* current, into number of turns, given in column 5, being for the particular section, together with the similar one, on the other side of the ring.

For Magnet, Fig. 4.

Section at.	Flow of mag. C.G.S. units.	Area of section, sq. cm.	Density of flow, C.G.S. units.	Current × No. of turns required for section. Ampere turns.
aa	32,000	4·0	8,000	For air gap 6360
bb	64,000	7·2	8,900	very small
cc	126,000	7·2	17,500	120
dd	147,000	12·9	11,400	70
ee	200,000	12·9	15,500	130
ff	225,000	12·9	17,500	320
gg	249,000	18·0	13,800	140
hh	270,000	18·0	15,000	160
ii	270,000	18·0	15,000	170
			TOTAL ...	7470

Column 2 shows what a large amount of magnetism leaks out from the one side of the ring and passes over to the other, not passing through the air gap at all. Column 3 shows how the

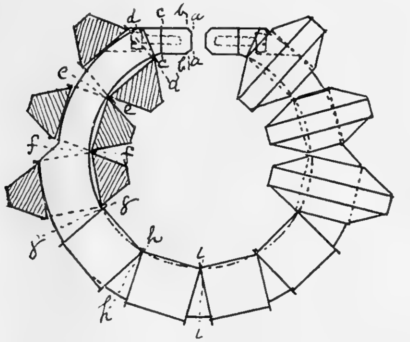


FIG. 4.—(Scale, quarter full size).

area of the iron has to be increased, owing to this leakage, for sections further away from the air gap. The current for this magnet is to be 5·4 amperes, and this flowing 1,500 times round should allow an ample margin to produce the field required.

It is interesting to compare the leading particulars of these two magnets.

Table comparing Two Magnets.

	Original magnet.	New design, Fig. 4.
Strength of field, C.G.S. units	7900	8000
Length of air gap, cm.	1	1
Area of air gap, sq. cm.	4	4
Exciting current, amperes	15	5·4
Turns of wire	3000	1500
Product of current, into number of turns, ampere turns	45,000	8100
Length of wire, yards	1140, No. 11	450, No 16.
Weight of wire, lbs.	139	17
Weight of iron in magnet, lbs.	41	15½
Total weight, iron and copper, lbs. ...	180	33
Cost of iron and copper—Iron @ 2·2*d.* per lb.; copper @ 1*s.* per lb.	£11 9 0	£2 11 0
Cost of working magnet continuously, per year, with current at 6*d.* per Board of Trade unit	£130 0 0	£25 0 0

Since the magnet was intended to work in connection with a submarine cable, it is quite safe to say it would require current throughout the year, and then, as the above table shows, there would be a saving of more than 100*l.* a year by using the magnet, Fig. 4, if the current could be got at 6*d.* per Board of Trade unit—it would, however, very likely cost much more under these conditions—to say nothing of the saving in first cost.

Another example of the importance of having sufficient iron in the magnetic circuit is afforded by the alterations that were made to an electro-magnet belonging to the Central Technical College. The cross section of its yoke was less than half that of the cores, due to the fact that the magnet was made before the theory of the magnetic circuit was understood. Recently a new yoke of proper cross section was made for the magnet, and it was found by experiment before and after the alteration that under precisely the same conditions the strength of the field had been just doubled simply by adding a few pounds of iron in the right place.

But at the same time it should be remembered that the magnetic properties of different specimens of iron vary enormously, and it is important that any iron which is to be used for a magnet should first be tested. Fig. 5 shows a very convenient apparatus for doing this. It consists of a massive iron frame into which you can slide a bar of the sample to be tested, the bar passing through a thin brass tube on which a known number of turns of wire are evenly wound. Also a few turns of fine wire are wound on the middle of the tube, shown at T, Fig. 5,

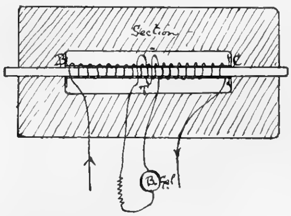


FIG. 5.

and connected to a ballistic galvanometer. A current is sent through the large coil, causing magnetism to flow through the bar, returning by the massive frame the cross section of which is so large that practically the whole of the magnetomotive force due to the current is used to send the magnetism through the bar; therefore, dividing the total ampere turns by the length of the bar we obtain the ampere turns necessary to send the magnetism through one centimetre of that specimen of iron. Several different strengths of current are sent through the magnetising coil, and in each case the flow of magnetism produced is measured by suddenly switching off the current, consequently causing the magnetism passing through the secondary circuit connected to the ballistic galvanometer to rapidly die out, and in doing so a quantity of electricity, proportional to the amount of magnetism, is sent through the galvanometer, thus giving a measure of the amount of magnetism. Fig. 6 shows the difference between three specimens of iron—I. cast iron, II. wrought iron, III. best cast steel for magnets.

The curves show how rapidly the magnetic resistance of iron rises as the density of magnetisation is increased, and therefore the importance of not allowing the density to exceed about

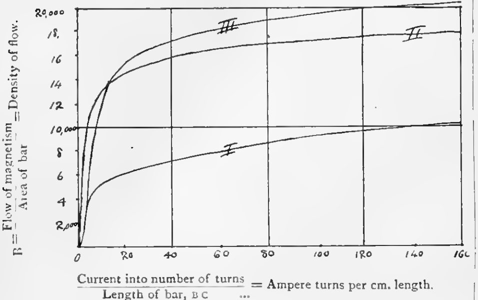


FIG. 6.

16,000 C.G.S. units. These curves are very useful in designing, because from them the ampere turns necessary to produce a certain density of magnetisation in a particular kind of iron can at once be found. It is most important to use the best steel, such as curve III. represents, for making magnets that are to produce very strong fields. With regard to what is meant by a very strong field, a field up to 20,000 C.G.S. units is moderately easily reached. But at about this limit saturation of the iron sets in and it becomes much more

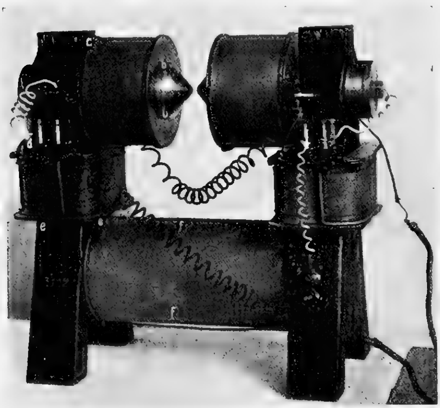


FIG. 7.

difficult to go higher. A field of 30,000 units is a very strong field; the cost of the magnet rises very rapidly if a stronger field than this is required. A field of 40,000 is about the strongest field obtainable. To go above this would require such a large additional expenditure in materials and power, compared with the small increase in the field, that it is not practical.

Fig. 7 shows a photograph of a good type of magnet to produce a very intense field. In this magnet the density of flow in the pole pieces is very great, so great, in fact, that the permeability of the pole pieces is not much greater than that of air; consequently a very large leakage of magnetism occurs, which makes the calculations very laborious. An idea of the amount of leakage that occurs is got from the fact that the flow of magnetism in the lower cylinder, Fig. 7, is fifty times greater than the flow across the air gap under working conditions, whereas in the case of the magnets of dynamo machines the flow in the yoke would not generally be more than 1·4 times the flow in the air gap, because they produce only relatively weak fields of about 6000 units. Owing to this great leakage the calculations cannot be made so accurately for this magnet, Fig. 7, as for dynamo magnets. In making the final calculations for this magnet it was necessary to divide the magnetic circuit in the pole pieces up into a great many sections, only two millimetres apart, finding the ampere turns necessary for each section, because the density changes so rapidly in the pole pieces, and also because the ampere turns required for the pole pieces are much greater than those required for the air gap, which cannot be helped, because the magnet was designed to produce a very intense field in a small air gap.

The following table gives the results of the final calculations:—

For Magnet, Fig. 7.

	Distance of section from pole tip in cm.	Section at.	Total flow of magnetism at section.	Area of section, sq. cm.	Density of flow of mag., C.G.S. units.	Product of current, into number of turns required for each section.
					For air gap 8900	
In pole piece	0	—	27,500	0·785	35,000	4,340
	0·2	—	53,000	1·54	34,400	3,500
	0·4	—	81,500	2·7	30,100	4,140
	0·8	—	139,500	5·7	24,500	763
	1·2	—	208,500	10·5	20,000	175
	2·2	—	375,500	27·3	13,800	24
	3·2	*bb*	535,000	52·75	10,150	660
		cc	925,000	52·75	17,500	183
		dd	1,054,000	80·0	13,100	540
		ee	1,206,000	80·0	15,100	894
		ff	1,374,000	85·0	16,100	
					TOTAL...	24,119

This magnet was originally intended to produce a field of 35,000 C.G.S. units, in an air-gap ⅛-inch long, for which the above calculations were made; but they show that the magnet will not be able to produce so strong a field as this, because it is wound so that it may be connected straight on to 200-volt mains, with all coils in series, or 100-volt mains with two sets of coils in parallel, and then there are 22,400 ampere turns available, whereas at least 24,120 are required.

Recently this magnet was made by the Electric Construction Company for the Solar Physics Laboratory, South Kensington, and the strength of the field produced under the conditions assumed in the above calculation was found to be 32,000 C.G.S. units, showing that the theoretical calculations agree fairly well with practice, considering the very high value of the field.

When the length of the air-gap was reduced to 2 millimetres, and the exciting current doubled, the maximum strength of field attained, for a short time, was nearly 38,000 C.G.S. units, which corresponds to a pull, between the pole pieces, of no less than 830 pounds per square inch! T. L. JAMES.

SOME RECENT WORK ON DIFFUSION.[1]

THE subject of my lecture is one which, though essentially of a physical nature, had its origin in what may be regarded as a no man's land, a strip of neutral territory which can be claimed exclusively neither by the physicists nor the biologists.

An attempt to reconcile some apparently contradictory facts connected with the nutrition of plants has led, somewhat unexpectedly, to an extension of the laws of gaseous diffusion, so that we shall have to deal with one of those comparatively rare cases in which biology has been able to react to some extent on physics.

It has long been known that the primary source of the carbon of all plants is the carbonic acid existing in small quantities in ordinary atmospheric air, and that their green parts, more especially the leaves, are able to utilise the energy of sunlight in decomposing the carbonic acid and water and building up from their elements a whole series of substances, such as sugars and starch, which contribute directly to the nutrition of the plant.

The immediate seat of this synthetic and assimilatory process is found in the minute green chlorophyll granules which occur in great numbers within the cells of the leaf tissue, and one of the first problems to be dealt with in the study of the process is to show in what manner the highly dilute carbonic acid of the air can gain entry into the leaf with sufficient rapidity to supply these assimilating centres with material for the needs of the plant.

In a typical leaf, such as is represented in section in the diagram, both sides are covered with a cuticle and epidermis pierced at regular intervals on one or both sides with extremely minute openings, whose size is capable of being regulated according to the requirements of the plant. These are the *stomates* which open out into a relatively large cavity within the leaf, and this cavity in turn communicates with the numerous and roomy air-spaces between the cells containing the green chlorophyll granules.

One of the most important functions of the stomates is undoubtedly to regulate the transpiration of water from the plant, but the question of how far these minute openings play a part in the interchanges of gases between the interior of the leaf and the outer air has been a subject of very lively controversy.

It is now about thirty years since the eminent French chemist, Boussingault, came to the conclusion that the carbonic acid of the air gains access to the leaf, not through the *stomates*, but through the continuous substance of the cuticle and epidermis, by a process of *osmosis* similar to that by which carbonic acid had been shown by Graham to pass through a thin film of india-rubber.

So convincing did Boussingault's experiments and arguments appear to his contemporaries that this view became an article of faith for something like a quarter of a century, until, in fact, some five or six years ago, when Mr. F. Frost Blackman took up the subject and proceeded most inconsiderately to shatter all the most cherished statements of our text-books on this question.

I regret that time will not allow me to do more than state the general conclusions at which Mr. Blackman arrived and which may be briefly summarised as follows:

In the first place there is no appreciable passage of atmospheric carbonic acid through the surface of a leaf which is naturally devoid of stomates, such, for instance, as the upper surface of a normal leaf, which is quite imperforate; neither is any entry of carbonic acid possible when the stomates have been artificially blocked or made to close spontaneously.

In addittion to this, if a leaf has stomates on both surfaces the relative in-take of carbonic acid by those surfaces bears a distinct relation to the distribution of the stomates.

We can, in fact, no longer doubt that when a leaf is respiring or assimilating mere osmosis of carbonic acid through the substance of the cuticle and epidermis plays little or no part in the gaseous exchanges, and that whatever the exact nature of the process may be it must be carried on exclusively by the minute openings of the stomates.

Since anything like a mass movement of the air through these openings is out of the question, we must look to the phenomena of *diffusion* for the true explanation, and especially to that form of it which was first described by Graham as *free diffusion*, that is to say the natural tendency possessed by gases or liquids to form a perfect mixture when they are in contact with each other and there is no partition of any kind between them.

[1] Discourse delivered at the Royal Institution, Friday, March 22, by Dr. Horace T. Brown, F.R.S.

This spontaneous mixing is quite independent of any currents or mass movements of any kind, and is brought about by the gradual interpenetration of the molecules of the one gas or liquid by the molecules of the other.

As an example of this kind of diffusion I have here a cylinder which a few weeks ago was partly filled with 5 per cent. gelatine solution. After the gelatine had set, the cylinder was filled up with a highly-coloured solution of a copper salt, which you now see has permeated the jelly to a certain depth. There has been no mixing of the solutions in the ordinary sense of the word, for the gelatine is virtually a solid. The effect has been produced by the molecules of the coloured copper salt, by reason of their rapid movement in all directions, gradually penetrating into the spaces between the molecules of the gelatine layer. Given a sufficient length of time and there would be an equal partition of the coloured substance between the two layers.

Diffusion takes place, as is well known, much more rapidly with gases than with liquids. Had our cylinder contained, for instance, carbonic acid in the lower half and air in the upper, a complete mixing would have taken place in a comparatively short time, even if all convection currents had been prevented.

The classical researches of Graham on the diffusion of gases through thin porous septa established the general law that the rate of diffusion of the different gases, under identical conditions, varies inversely as the square roots of their respective densities. Graham's results, however, only acquaint us with the *relative* velocities of diffusion, whereas for the particular problem which we have before us we must know the *absolute* velocities of diffusion under strictly defined conditions.

It is mainly to the Viennese school of physicists, and especially to Prof. Loschmidt, that we owe our present knowledge of the actual rate of penetration of one gas by another in free diffusion.

By observing the speed with which different pairs of gases spontaneously mix in a tube, Loschmidt was able to deduce certain *absolute values* expressing the velocity of their interpenetration.

Some of these results for different pairs of gases are given in the diagram, the last column representing the "constant of diffusivity" expressed in centimetre-gram-second units.

Let us consider the constant for carbonic acid and air, which at 0° C. is ·142. This means that when air and carbonic acid gas are freely diffusing into each other, an amount of either gas corresponding to ·142 cubic centimetre will pass in one second of time across an area of one square centimetre when the partial pressure of the gas varies by one atmosphere in one centimetre of length.

Now when we come to apply these absolute values of diffusivity to the passage of the extremely dilute CO_2 of the air into the leaf stomates (whose dimensions can of course be determined), we find that free diffusion through these openings is apparently able to account for only a portion of the gas which we know must enter the leaf, unless we make some extremely improbable assumptions as to the very low point at which the partial pressure of the carbonic acid is maintained immediately under the apertures.

I shall not, however, trouble you with the calculations on which this statement is based, since I prefer to put the matter in a more concrete form, which has also the advantage of emphasising the extraordinary power which an assimilating leaf possesses of extracting carbonic acid from its surrounding air.

There are two methods by which we can determine the actual amount of atmospheric carbonic acid used up by an assimilating leaf, one a direct the other an indirect method.

Part of the apparatus used in the direct method is shown on the table.

The leaf, which may be still attached to the plant, is enclosed in a glazed case, through which a measured current of air is drawn of which the carbonic acid content is accurately known. When the air emerges from the case it passes through an absorption apparatus, which retains the whole of the CO_2 left in the air after passing over the leaf. This absorbed carbonic acid is determined at the close of the experiment, and we then have all the data for estimating the carbonic acid abstracted from the air by the leaf. The area of the leaf being known, the CO_2 absorbed can be referred to a unit area of leaf and a unit time.

By the indirect method, which is due to Sachs, the actual increase in dry weight of a given area of an assimilating leaf is determined, and since this increase in weight is due to substances having a definite percentage of carbon a simple calculation enables us to determine the equivalent amount of carbonic acid abstracted from the air.

By such methods as this it can be shown that an actively assimilating leaf, such as that of the Catalpa tree, in full daylight, and under favourable conditions of temperature, can take in carbonic acid from the air at the rate of about 1/10th cubic centimetre per hour for each square centimetre of leaf.

Since there are only about three volumes of carbonic acid in 10,000 volumes of ordinary air, this must mean that in a single hour the under surface of the leaf will take in as much carbonic acid as is contained in a column of air about eight feet long, and having the same area of cross-section as the leaf.

But this remarkable power of an assimilating leaf will be better appreciated if we compare it with a liquid surface of a strong solution of caustic alkali, which is known to have such a great avidity for carbonic acid.

We can investigate the absorptive power of such solutions for the carbonic acid of the air under fixed and controllable conditions by using a form of apparatus which I have on the table, and which can be examined at the close of the lecture. It is so arranged that an air current of known velocity can be drawn over the surface of the absorbing solution which has a known area.

When a very low velocity of the air current has been reached the amount of absorption becomes constant at ordinary temperatures at about ·17 c.c. of carbonic acid per square c.m. of surface per hour.

So we see that a leaf, assimilating under natural conditions, is taking in carbonic acid from the air more than half as fast as a surface of the same area would do if it were wetted with a constantly renewed film of a strong solution of caustic alkali submitted to a strong current of air.

This is in itself a somewhat remarkable conclusion, but what are we to say to a proposition which would limit the absorptive power of the leaf surface to the extremely small apertures of the stomates?

In a leaf such as we have been considering, the aggregate area of the openings of the stomates, when expanded to their widest, amounts to less than *one per cent.* of the total leaf surface, so that if the entry of the CO_2 takes place exclusively by these openings we must conclude that it goes in more than fifty times faster than it would do if the mouth of each one of these minute openings were filled with a constantly renewed solution of strong caustic alkali.

Such facts make it difficult unreservedly to accept the view that the gaseous exchanges in leaves are really carried on exclusively by the stomates, which occupy such a small fraction of the leaf surface. On the other hand, the direct experimental evidence in favour of this view is overwhelming, so that we apparently find ourselves on the horns of a dilemma.

There appeared to be only one way out of the difficulty, that was to assume that the leaf knows more about the laws of free diffusion than we do, and has adapted itself to some physical principles which have hitherto escaped notice. This was found to be the case when the structure of the leaf was regarded as a piece of physical apparatus for promoting rapid diffusion.

I do not propose to take you through the various and tedious stages by which the true explanation was reached, but will attempt, as far as possible, to short-circuit the current of the argument.

In the first place I wish to call your attention to a particular mode of free diffusion which, in gases, has been but little studied, but which has a very direct bearing on diffusion in the living leaf, where one of the constituents of the diffusing gases, the carbonic acid, is very small in amount compared with the others.

Let us for a moment concentrate our attention on the air which is contained in this open glass cylinder, and endeavour to picture to our minds the jostling crowds of the perfectly elastic molecules of the various gases, flying hither and thither in all imaginable directions and coming into frequent collision with each other and the sides of the containing vessel.

Now in this jostling throng there is a certain proportion of molecules of *carbonic acid*, which we will imagine for the moment are distinguished from the molecules of the other gases by some difference in colour—let us suppose them to be *green*.

Now further consider a plane surface in the contained air of the cylinder; from the dynamical theory of gases it follows that in any given interval of time, temperature and pressure remaining constant, the same average number of the "green" molecules will cross this imaginary plane in opposite directions, and since this will be true for any plane surface, no matter where we take it within the cylinder, there can be no change in the average distribution of the "green" molecules throughout the cylinder—in other words, no change in any part of the cylinder in the composition of the air as regards its carbonic acid content.

But now let us imagine that the bottom of the cylinder is suddenly made capable of absorbing carbonic acid, say by the introduction, without any disturbance of the air, of a little solution of caustic soda or caustic potash. The "green" molecules which now strike the bottom of the cylinder at all imaginable angles of incidence will not all rebound as they originally did, but will be to a large extent trapped in their to and fro excursions, so that in the very first brief interval of time a very thin stratum of air, parallel to and immediately above the absorbing surface, will be partially freed from its "green" molecules.

Now consider the kind of exchange of "green" molecules which occurs in the next very brief interval of time between this partially depleted layer at the bottom and the one immediately above it. The rate of exchange across the imaginary plane dividing these two contiguous layers can no longer be equal and opposite since the number of "green" molecules in the upper stratum is greater than that in the lower. A larger number of the "green" molecules must consequently pass in a given brief interval of time from the higher to the lower stratum than from the lower to the higher; in other words, the *balance of exchange* is in favour of the lower layer. This state of affairs will rapidly propagate itself upwards until the mouth of the cylinder is reached, and, provided the air outside the cylinder is kept of the same composition and the absorptive power of the bottom of the cylinder is also kept constant, these *uncompensated balances of exchange* between the imaginary layers may be regarded as constituting a steady *flow* or *drift* of the "green" molecules down the tube towards the absorbent surface.

Although within the column there is this constant flow of carbonic acid molecules in the general direction of the axis of the tube, the system as a whole may now be regarded as static as long as all the conditions remain unchanged. The flow is, then, strictly analogous to the "flow" of heat in a bar of metal which is kept with its two ends at a uniform difference of temperature, or to the flow of electricity in a conductor between two regions maintained at a constant difference of potential; and static diffusion admits of precisely the same simple mathematical treatment as these phenomena of conduction of heat or electricity when we come to its quantitative study.

In such an imaginary experiment as we have been considering it is clear that the amount of carbonic acid in the air of the cylinder must vary uniformly from a maximum at the top of the cylinder to a vanishing point at the bottom, so that if the CO_2 really had the green colour which, for purposes of argument, we have attributed to it, the depth of colour of the air column would uniformly diminish from top to bottom.

This can be illustrated by the diffusion of a coloured copper salt down a gelatine column. If this column were cut off just where the colour ceases to be perceptible, and the cut end were immersed in water to carry off the diffusing salt as fast as it came through the column, then if the upper end of the column remained in contact with the coloured copper solution we should ultimately get a constant steady flow of the salt down the column.

Under these conditions it can be readily shown, both experimentally and theoretically, that the actual amount of substance diffusing down the column in a given time will, in the first place, be directly proportional to the difference in the concentration of the diffusing substance at the two ends of the column; it will also be directly proportional to the *area* of cross-section of the column, but inversely proportional to its length.

The fact which for the moment I wish you to bear in mind is that, all other things being the same, the amount of diffusion down a column of this kind *varies directly as the area of the cross-section of the column.*

This is roughly illustrated by these two cylindrical columns of gelatine of different diameters, down which a coloured solution has been diffusing for equal times.

The salt has penetrated both columns to the same depth, and the gradation of colour is also the same, a proof that the rates of diffusion down the columns must be proportional to their areas of cross-section.

But now let us consider what will happen if instead of varying the width of the column throughout its entire length we only partially obstruct the cylinder somewhere in the line of flow, say by means of a thin diaphragm pierced with a single circular hole of less diameter than the bore of the tube.

We must resort to experiment to answer this question.

Suppose we take a series of exactly similar flasks, such as I have here, and produce a steady flow of atmospheric carbonic acid down their necks by partially filling each flask with a solution of caustic soda, the amount of carbonic acid entering the flasks being determined by subsequent titration of the soda solution. We can then study the effect produced by partially obstructing the mouths of the flasks with thin discs of metal or celluloid pierced with a single hole of definite size.

The results of a series of experiments of this kind are given in Table I., and you will see that under these conditions the amounts of carbonic acid diffusing down the cylindrical necks in a given time are not proportional to the areas of the apertures, as might reasonably have been expected, but are directly proportional to their *diameters*.

TABLE I.

Diffusion of Atmospheric CO_2 through single apertures of varying size.

Diameter of Aperture	CO_2 diffused per hour	CO_2 diffused per sq. cm. per hour	Ratio of Areas	Ratio of Diameters	Ratio of CO_2 diffused
mm.	c.c.	c.c.			
22·7	·2380	·0588	1·00	1·00	1·00
6·03	·0625	·2186	·07	·26	·26
3·23	·0398	·4855	·023	·14	·16
2·11	·0260	·8253	·008	·093	·10

This, of course, implies that as we make the aperture smaller the flow through a given unit of its area is proportionately increased; in other words, the acceleration of flow is *inversely proportional to the diameters of the apertures*.

This unexpected fact, which lies at the root of the whole question we are considering to-night, may be experimentally illustrated in a variety of ways.

We may, for instance, cause the aqueous vapour of the air to diffuse into a similar series of flasks, using in this case strong sulphuric acid as the absorbent, and determining the amount of diffusion of the water vapour by weighing the flasks from time to time. You will see from the results of such an experiment that the diffusion rates again follow pretty closely the ratios of the diameters of the apertures, and are widely divergent from the ratios of areas. (See Table II.)

TABLE II.

Diffusion of Aqueous Vapour through apertures of varying size.

Diameter of Apertures	Ratio of Areas	Ratio of Diameters	Ratio of Diffusion for equal times
mm.			
2·117	1·0	1·0	1·0
3·233	2·3	1·52	1·55
5·840	7·6	2·75	2·54

This "diameter law" is also applicable to circular liquid surfaces, the amount of absorption or evaporation from such surfaces varying, under certain conditions, not in accordance with the area of the surfaces, as might have been expected, but with their diameters.

I have here a short burette-like tube with a wide rim of metal round the top. When this tube is completely filled by letting in a solution of caustic soda we have a circular surface of the solution lying in the same plane as the rim. When this has been exposed to the air for a given time the carbonic acid absorbed by the disc of liquid can be determined by drawing off and titrating.

If such absorptive discs of different dimensions are exposed to air which is in *slight movement*, we shall find that the carbonic acid absorbed is proportional to the *area* of the surface. The smaller, however, we make the discs, and the greater precautions we take to keep the air over them perfectly still, the nearer do the absorptions become proportional to the diameters. (See Table III.)

There is always, however, more difficulty in obtaining these results with plane absorbing surfaces than by diffusion through a perforated diaphragm. The reason for this will be apparent later.

TABLE III.

Absorption of Atmospheric CO_2 by Circular Surfaces of Solutions of Caustic Alkali.

Diameter of Surface mm.	Ratio of Areas.	Ratio of Diameters.	Mean Ratio of Areas and Diameters.	Ratio of CO_2 absorbed.
10·25	1·0	1·0	1·0	1·0
20·25	3·9	1·9	2·9	3·0
29·25	8·1	2·8	5·4	5·3
40·00	15·2	3·9	9·5	9·2
5·0	1·0	1·0	—	1·0
10·25	4·2	2·05	—	2·47

Before entering on an explanation of these facts I wish you to note a very important conclusion to be drawn from them, and one which readily admits of experimental verification.

We have seen that when we partially obstruct the diffusive flow of a gas or liquid by a thin septum with a single circular perforation, the velocity of the flow through each unit area of aperture increases as the diameter of the aperture decreases.

One might, therefore, expect that if a number of fine holes were suitably arranged in such a septum, the acceleration of flow through the individual holes might assume such proportions that a perforated septum of this kind would exercise little or no obstruction on the diffusive flow, although in such a case the aggregate area of the holes might only represent a small fraction of the total area of the obstructing septum.

Strange and paradoxical as such a conclusion may at first sight appear, it will bear the test of experiment.

I have here a thin film of celluloid; in fact, a piece of the ordinary Kodak roller-film. This has been perforated with holes about ·4 millimetre in diameter, arranged at a little more than 2·5 diameters apart, so that there are just one hundred of such perforations on a square centimetre of area. The clear holes represent about 1/10th of the area of the film, 9/10th of the sieve being blocked up with impervious celluloid.

Here are two columns of gelatine, down which a blue solution of copper-ammonium sulphate has been diffusing for equal times. One of these columns is unobstructed in any way, being in direct contact with the coloured liquid. In the other case a finely perforated celluloid film has been interposed, which has the effect of blocking out 9/10ths of the cross-section of the column. You see that, notwithstanding this, there is no appreciable difference in the amounts of coloured salt which have diffused in the two cases; the salt has, in fact, gone through the finely-pierced septum as readily as if no obstruction were present.[1]

We find that exactly the same holds good with gaseous diffusion.

If finely perforated septa of this kind are luted on to short tubes containing caustic soda and are exposed to still air, the amount of carbonic acid diffusing through the holes in the diaphragm can be compared with the amount which we know would diffuse down the open tube under like conditions.

Some results of this kind are given in Table IV.

[1] The celluloid film is itself not permeable.

TABLE IV.

Diffusion of Atmospheric CO_2 through Multiperforate Septa into Tube 4 c.m. long. Diameter of Holes ·380 m.m.

No. of Holes per sq. cm.	Diameters Apart.	CO_2 Diffusing through Septum per hour c.c.	Open Tube Diffusion per hour c.c.	Percentage of Septum Diffusion on Open Tube Diffusion.	Percentage area of Cross-section occupied by Holes.
100	2·63	·361	·346	104·3	11·34
25	5·26	·148	·342	43·2	2·82
11·11	7·8	·131	·352	37·2	1·25
6·25	10·52	·110	·353	31·1	·70
15·7	15·7	·068	·334	20·4	·31

I must now ask you to follow me in a somewhat theoretical excursion in quest of an explanation of these curious facts.

(To be continued.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following have been elected public examiners:—Mr. R. T. Glazebrook, in physics; Mr. P. Elford, in chemistry; Prof. F. Gotch, in physiology.

The curators of the University Chest have been authorised to spend a sum not exceeding 1400*l.* in certain extensions of the Chemical Department which are necessitated by the loss of the laboratory known as the "Glastonbury Kitchen." The latter is now required as access to the new Radcliffe Library.

A proposal to permit candidates for the degree of Bachelor of Letters or Science to keep more than one term of University residence in the year by residence during the vacation has been rejected.

A proposal to provide access for wheeled traffic to the Departments of Physiology, Human Anatomy and Pathology at the back of the University Museum has also been rejected owing to the opposition of those who regard this as an encroachment upon the University Park.

The Junior Scientific Club held their 226th meeting on May 31. A paper was read by E. Walls, entitled "The Quest of the Philosopher's Stone." Prof. Silvanus Thompson delivered the Boyle Lecture on June 6, on "Magnetism in Growth."

CAMBRIDGE.—In the mathematical tripos, part i., the senior wrangler is Mr. A. Brown, of Caius College, a Ferguson student from Edinburgh. Miss Reynolds, of Newnham, is bracketed 11th wrangler. Three names appear in the first class of part ii.: Mr. J. E. Wright, Trinity (senior wrangler 1890); Mr. T. H. Havelock, St. John's (15th wrangler); and Mr. J. Chadwick, Pembroke (5th wrangler). Miss W. M. Hudson, Newnham, is in the first division of the first class (bracketed 8th wrangler 1890).

The professor of pathology announces ten separate courses of lectures and practical work to be given in the long vacation, beginning July 8.

PROF. R. W. WOOD, of the University of Wisconsin, has been appointed professor of physics in the Johns Hopkins University, in succession to the late Prof. H. A. Rowland.

WE learn from *Science* that the Wisconsin Legislature has granted 210,000 dollars to the University of Wisconsin, at Madison, in addition to the regular income previously derived from the State. Of this sum 150,000 dollars is for a new building for the College of Agriculture, which is to house the administration offices of this department and the experiment station as well as the departments of bacteriology and chemistry. This College also receives 10,000 dollars annual increase to its present income. The College of Engineering receives 30,000 dollars for equipment of its new building, which was provided by the last Legislature; also 7500 dollars annual increase in income. The newly organised School of Commerce secures 3500 dollars annual increase.

DR. H. M. KYLE has been appointed naturalist to the Marine Biological Association and fisheries' instructor for the county of Devon. Dr. Kyle is a distinguished graduate of the University of St. Andrews, having gained the rector's prize for an essay on evolution and having held successively the Fisheries' prize, the Berry scholarship (100*l.*) and, for three years, the Exhibition of 1851 scholarship (150*l.*) for original researches in connection with the fisheries. His studies for seven years have been devoted to marine zoology and the scientific treatment of the problems of the fisheries at the chief marine laboratories of Europe, including Naples, Plymouth, &c., and both the old laboratory and the new (Gatty) laboratory at St. Andrews, where he was trained.

WE learn from the *Berliner Klinische Wochenschrift* that the second annual congress of the German Association for School Hygiene, which was founded about two years ago for the purpose of studying and promoting all matters relating to health and hygiene in connection with schools, was held at Wiesbaden on May 31. The municipal authorities of that city placed the "Curhaus" at the disposal of the council of that association, where all the official meetings were held during the congress. The attendance was a large and a representative one, and the programme contained many important and highly instructive subjects, of which the following may particularly be mentioned: (1) the new Prussian school reform in relation to school-hygiene; (2) the hygienic condition of German schools in general, with special reference to that of Wiesbaden; (3) the prevention of infectious diseases regarded from a general point of view, with special reference to the spread of tuberculous affections amongst school children.

THE *Educational News* of Scotland states that the following is the list of candidates for the chair of natural philosophy in Edinburgh University, vacant through the resignation of Prof. Tait:—Prof. J. C. Beattie, South African College, Cape Town; Prof. G. H. Bryan, F.R.S., University College, North Wales; Dr. Charles Chree, F.R.S., National Physical Laboratory, Richmond; Dr. Cargill G. Knott, University of Edinburgh; Prof. J. P. Kuenen, University College, Dundee; Dr. Charles H. Lees, Owens College, Manchester; Mr. David B. Mair, Civil Service Commission, London; Prof. J. A. M'Clelland, University College, Dublin; Prof. J. G. MacGregor, F.R.S., Dalhousie University, Halifax, U.S.A.; Prof. Karl Pearson, F.R.S., University College, London; Mr. G. F. C. Searle, Cambridge; Mr. George W. Walker, Cambridge; Mr Gilbert T. Walker, Cambridge; Mr. C. T. R. Wilson, F.R.S., Cambridge.

PROF. RAMSAY expressed the views of a number of teachers and investigators in the annual oration delivered by him at University College, London, last week, on "The Functions of a University." The essential principle of University work should be research. This, said Prof. Ramsay, should be the goal to be clearly kept in view in the philosophical faculties of Universities. He was not one of those who would urge that a young man should not learn a great deal of what had been already discovered before he attempted to soar on his own wings. But there was all the difference in the world between the point of view of the student who read in order to qualify for an examination, or to gain a prize or scholarship, and the student who read because he knew that thus he would acquire knowledge which might be used as a basis of new knowledge. It was that spirit in which our Universities were so lamentably deficient; it was that spirit which had contributed to the success of the Teutonic nations, and which was beginning to influence the United States. A University which did not increase knowledge might be a technical school or a coaching establishment, but it had no claim to the name University. The best way of fitting young men for the manifold requirements of the Empire was to give them the power of advancing knowledge.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, May 16.—Prof. Emerson Reynolds, president, in the chair.—The following papers were read:—Derivatives of methylfurfural, by H. J. H. Fenton and Miss M. Gostling. A simple method of obtaining pure methylfurfural is described.—Optically active nitrogen compounds and their bearing on the valency of nitrogen; dextro- and lævo-α-benzylphenylallylmethylammonium salts, by W. J. Pope and A. W. Harvey. The authors have prepared in a state of purity a number of substances owing their optical activity to the presence of an asymmetric nitrogen atom; it is shown that *d*- and *l*-benzylphenylallylmethylammonium iodides and bromides slowly become optically inactive when preserved in chloroform solution.—Reactions of hydroxyoxamides, by R. H. Pickard and W. Carter. Hydroxyoxamide and its phenyl-, tolyl- and naphthyl-derivatives give the general reactions of hydroxamic acids and are thus quantitatively convertible into substituted biurets and allophanates.—The *sym*-trichlorobromoanilines, and chloro- and bromo-amino-derivatives of chlorobromoacetanilides, by F. D. Chattaway and K. J. P. Orton. The authors call attention to the great resemblance existing between the two similarly constituted *sym*-chlorodibromoanilines, their acetylderivatives and the two *sym*-dichlorobromoanilines respectively.—Replacement of bromine by chlorine in anilines, by F. D. Chattaway and K. J. P. Orton.—The absorption spectra of cyanogen compounds, by W. N. Hartley, J. J. Dobbie and A. Lauder. An examination of the absorption spectra confirms the view that cyanuric acid and methyl cyanurate are similarly constituted, and indicates that the relations between melamine and triethylmelamine are correctly represented by the commonly accepted formulæ.—The nutrition of yeast. Part iii. By A. L. Stern. The author concludes that any increase of nitrogenous or inorganic nutriment beyond a definite limit will not increase either the amount of nitrogen assimilated by yeast or the weight of the yeast; any increase of the added sugar, however, is accompanied by an increase both in the amount of nitrogen assimilated and in the weight of the yeast. The growth of yeast proceeds as long as any sugar remains unfermented and is, during part of the fermentation, proportional to the amount of sugar fermented.—On the colloid form of piperine, with especial reference to its optical refraction and dispersion, by H. G. Madan. On cooling piperine, after heating to 180° for an hour, it remains in the colloidal state for an indefinite time; the colloid has a high refractive index ($\mu_D = 1{\cdot}684$) and exhibits an extraordinarily high dispersive power.—Note on pyromucylhydroxamic acid, by R. H. Pickard and A. Neville.—The condensation of ethylphenylketone with benzaldehyde, by R. D. Abell. Ethylphenylketone and benzaldehyde condense in presence of sodium ethoxide with formation of 1:3-diphenyl-2-methyltrimethylene glycol, benzalpropiophenone and 1:3-dimethyl-1:3-dibenzoyl-2-phenylpropane.—A new method for the determination of hydrolytic dissociation, by R. C. Farmer. The author's method of ascertaining the extent of hydrolytic dissociation depends upon determinations of the free acid or base by distribution between two solvents, one of which dissolves only one of the dissociation products.—The production of some new metallic borides, by S. A. Tucker and H. R. Moody. Crystalline borides having the compositions Zr_3B_4, CrB, WB_2 and Mo_3B_4 are prepared by heating the corresponding metal with boron in the electric furnace.—The action of lead thiocyanate on the chlorocarbonates. Part ii. Carboxymethyl- and carboxyamylthiocarbimides and their derivatives, by R. E. Doran.—The chlorine derivatives of pyridine. Part vii. Some condensation products, by W. J. Sell and F. W. Dootson.—The diazotisation of dinitroanisidine and the constitution of the resulting product, by R. Meldola and J. V. Eyre.

MANCHESTER.

Literary and Philosophical Society, May 28.—Prof. Horace Lamb, F.R.S., vice-president, in the chair.—The influence of grinding upon the solubility of the lead in lead fritts, by Dr. T. E. Thorpe, C.B., F.R.S., and Mr. Charles Simmonds. The paper was a criticism of the methods and conclusions contained in a paper by Messrs. Jackson and Rich, read before the Society in October last. The argument of that paper was stated to rest on the assumption that a fritt behaves as a single chemical compound—an untenable assumption. The theory that as a fritt is dissolved by acid a layer of silica is formed on the outside of the particles, protecting them from further action, was opposed as not being in accordance with facts which are easily demonstrated. The particular fritts used by Messrs. Jackson and Rich in their experiments were of somewhat high solubility, and the conclusions arrived at did not hold for those of lower solubility. A fine powder was, indeed, somewhat more soluble than a coarse one, but the variations of solubility of slightly soluble glazes between the limits of fineness occurring in actual practice were of inconsiderable magnitude. Further, whether or not the solubility varied to some extent with the fineness, the matter was of no practical consequence, since glazes could be obtained, and were in use, which were of the fineness used in working and conformed to the limit of solubility suggested by the Home Office. In the discussion which followed Mr. Burton pointed out that even if grinding only produced—as in experiments actually made with fritts of solubility below the Home Office standard—variations of solubility of some 50 per cent., a fritt not far within the limit would be dangerous in use or not according to the fineness of grinding. He also denied that the more soluble fritts are the softer, as alleged by Dr. Thorpe, but stated that the opposite was the fact. He referred to the danger of lead poisoning from inhaled lead dust, a matter in which solubility in dilute acid did not come into account. Mr. Jackson stated that the finer portions of the fritts dealt with by himself and Mr. Rich contained not more but less lead oxide than the coarser portions, contrary to the suggestions of Dr. Thorpe. He mentioned that he had himself found solubilities of from below 2 per cent. to about 5 per cent. from the same fritt at different grindings, the fritt being one which had been passed by Dr. Thorpe as within the Home Office limit. He showed some photographs of glasses acted on by hydrofluoric acid, showing crystalline forms suggestive of distinct heterogeneity even in the clearest glass, and stated that he had certainly not treated the fritts as single chemical substances.

PARIS.

Academy of Sciences, June 5.—M. Fouqué in the chair.—New researches on the neutralisation of phosphoric acid, by M. Berthelot. When an excess of a solution of lime is added to phosphoric acid, the calcium phosphate precipitated has at first the composition $Ca_3(PO_4)_2$, but in presence of an excess of lime a more basic salt is gradually formed, which finally approximates to the composition $H_3PO_4.2CaO$. An analogous compound has been observed in nature, the oxychloride $CaCl_2$, 3CaO. Similar compounds appear to be formed with baryta.—New researches on the alloys of gold and silver and of other materials arising from Egyptian tombs, by M. Berthelot. Analyses of fragments of gold of the eleventh, twelfth and thirteenth dynasties, of a supposed perfume, and of a copper alloy.—On the magnetic analysis of the radium rays and of the secondary radiation provoked by these rays, by M. Henri Becquerel. A development of the method described in a previous paper.—The physiological action of the radium rays, by MM. Henri Becquerel and P. Curie. Radiferous barium chloride carried on the arm in a thin guttapercha envelope caused at first a reddening of the skin resembling a burn, but without pain. After some days the area of this increased and the skin was broken, and fifty-two days after the action of the rays there still remained a sore. In another experiment with a more active material, the effect of the rays was felt through a glass tube containing the material, a box and the clothes. Inflammation with suppuration was produced in this case after only six hours' exposure to the rays, the wound produced not being entirely healed until forty-nine days after the exposure.—The changes in direction and velocity of an air current which has encountered bodies of divers forms, by M. Marey.—On regressive erosion in the chain of the Andes, by M. de Lapparent. Owing to the possibility of rapid variation of the watershed in this region, the line marking the watershed between the Pacific and Atlantic Oceans, as it exists to-day, does not constitute a true geographical boundary.—On the tellurides of gold and silver in the region of Kalgoorlie in Western Australia, by M. Ad. Carnot. Some analyses of the West Australian minerals sent to the Paris Exhibition. With the exception of some traces of mercury and copper these are practically double tellurides of gold and silver of the type $(Au, Ag,)Te_2$.—On the longitudinal and transversal waves in perfect fluids, by M. P. Duhem.—Contribution to the theoretical and experimental study of liquid veins deformed by obstacles, and on the determination of the lines of induction in a magnetic field, by Prof. H. S. Hele-Shaw. A description of the author's method of photographing stream lines, with three examples. The method not only allows of the verification experimentally of many of the results deduced theoretically in hydrodynamics, but also furnishes a complete solution of many problems of practical importance which it is impossible to attack by mathematical analysis.—Determination of the surfaces which are at the same time surfaces of Joachimsthal and surfaces of Weingarten, by M. L. Raffy.—Observations on electric resonance in rarefied air, by M. Albert Turpain.—The influence of temperature on the electromotive force of magnetisation, by M. Rene Paillot. Using the method described in a previous paper, it was found that the electromotive force of magnetisation of soft iron increases with the temperature, this variation with the temperature being greater as the field is more intense. With bismuth the opposite effect is observed, the electromotive force of magnetisation falling off as the temperature is raised.—The action of the X-rays on conductors and on insulators, by M. J. Semenow. —On the alloys of aluminium. Compounds of aluminium with molybdenum, by M. Leon Guillet. By reducing molybdic acid with a large excess of aluminium three definite compounds were obtained corresponding to the formulæ Al_4Mo, $AlMo$, Al_7Mo, analyses of which are given.—On the alloys of aluminium and magnesium, by M. Boudouard. A set of determinations of the melting points of thirteen aluminium-magnesium alloys ranging from pure aluminium to pure magnesium. The curve of results presents three minima and two maxima, pointing to the existence of two definite compounds, $AlMg_2$ and $AlMg$.—On the cellular structure of some metals, by M. G. Cartaud.—Acidimetry of phosphoric acid by baryta, strontia and lime, by M. J. Cavalier. —On the aluminium contained in mineral waters, by M. F. Parmentier. The author points out that in spite of numerous analyses of the waters from Puits Chomel and Grande Grille the presence of aluminium in notable quantity has been overlooked.—The action of isobutylene bromide on benzene in presence of aluminium chloride, by M. F. Bodroux. The principal products are a butyl-benzene and dimethyl-phenyl-benzyl-methane.—The action of the alkyl malonic esters upon the diazoic chlorides, by M. G. Favrel. Ethyl-methylmalonate, treated with a solution of diazobenzene chloride in presence of sodium acetate, gives the phenylhydrazone of ethyl pyruvate. Diazoparatoluene gives an analogous reaction.—On a new mode of decomposition of bisulphite derivatives, by MM. P. Freundler and L. Bunel. Alkaline nitrites may replace the alkaline carbonates in this reaction —On the secondary products formed in the action of sulphuric acid upon wood charcoal, by M. A. Verneuil. The tetra-, penta- and hexa-carboxylic acids of benzene can be isolated from the residue.—On a new gregarian parasite of the mussel, by M. Louis Leger.—On the cilia of the Ctenophoræ and on ciliary insertions in general, by M. P. Vignon.—Experimental researches on the respiration of annelids. Study of *Spirographis Spallanzanii*, by M. Bounhiol. —The defensive or odorous glands of the cockroach, by M. K. Bordas.—On the structure of the shoot in ligneous plants, by M. Marcel Dubard.—On the proportion of water compared with the ripening of ligneous plants, by M. F. Kövessi.—On the electrolysis of animal tissues, by M. Édouard Branly.—The sources of iodine in the organism. The biological cycle of this metalloid, by M. P. Bourcet.—A method of preparing low brewery yeasts fermenting at a high temperature, by M. Georges Jacquemin.—The otoliths and audition, by M. Pierre Bonnier. —A case of trichosporia (*piedra nostras*) observed in France, by M. Paul Vuillemin.—On the thunderstorm in Paris of May 29, by M. J. Jaubert.

DIARY OF SOCIETIES.

THURSDAY, JUNE 13.

ROYAL SOCIETY, at 4.30.—Bakerian Lecture: Prof. James Dewar, F.R.S. —The Nadir of Temperature and Allied Problems. (1) Physical Properties of Liquid and Solid Hydrogen; (2) Separation of Free Hydrogen and other Gases from Air; (3) Electric Resistance Thermometry at the Boiling Point of Hydrogen; (4) Experiments on the Liquefaction of Helium at the Melting Point of Hydrogen; (5) Pyro-Electricity, Phosphorescence, &c.

MATHEMATICAL SOCIETY, at 5.30.—Remarks on the Quartic Curve $2\alpha^3\beta+m\beta^3\gamma+n\gamma^3\alpha=0$: A. B. Basset, F.R.S.—The Theory of Cauchy's Principal Values, II.: G. H. Hardy.—The Rational Solutions of the Equation $u^3+v^3+w^3+p^3=0$: Prof. Steggall.—Invariants of Curves on the same Surface, in the Neighbourhood of a Common Tangent Line: T. Stuart.

FRIDAY, JUNE 14.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Observations of Mars made at Mr. Edward Crossley's Observatory, Bermerside, Halifax, during the Opposition of 1900–01: J. Gledhill.—A Modified Form of Revolving Occulter for Adapting the Exposure of the Sun's Corona to its Actinic Intensity at all Distances from the Moon's Limb: D. P. Todd.—The Oxford Determinations of Stellar Parallax—Reply to Prof. Turner: Sir D. Gill.—Sun-spots and Magnetic Disturbance: W. Ellis.—Observations of Nova Persei made at Birr Castle, Parsonstown: The Earl of Rosse.—Secular Variation in the Period of R. Carinæ: A. W. Roberts.—The Great Comet of 1901, as observed at the Royal Observatory, Cape of Good Hope: Sir D. Gill.—The Oxford Determinations of Stellar Parallax—Further Reply to Sir D. Gill: H. H. Turner.—Measures of Double Stars made at Mr. E. Crossley's Observatory, Bermerside, Halifax: J. Gledhill.—Corrections to reduce the Revised Madras Catalogue of Stars for 1835·0 to the Fundamental Catalogue of Auwers: A. M. W. Downing.—The Lyrids, 1901 April, observed at Cambridge: J. C. W. Herschel.

PHYSICAL SOCIETY, at 5.—On Herr Jahn's Measurements of the Electromotive Force of Concentration Cells: Dr. R. A. Lehfeldt.—Exhibition of a Set of Specimens of Jena Glass: Prof. S. P. Thompson, F.R.S.

MALACOLOGICAL SOCIETY, at 8.—Notes on *Ariophanta*, *Xestina*, *Nilgiria* and *Euplecta*: W. T. Blanford.—Pleistocene Shells hitherto unrecorded from the Raised Beach of Perim Island, Red Sea: Rev. R. Ashington Bullen.—On a Dibranchiate Cephalopod from the London Clay of Sheppy: G. C. Crick.—(1) Description of a New Species of *Acanthochites* from South Africa; (2) Description of a New Species of Helicina from the Pelew Island: E. R. Sykes.—On the Anatomy of *Helix politissima*, Pfeiffer, and its Generic Position in the Ariophantinæ: Lieut.-Colonel H. H. Godwin-Austen.

TUESDAY, JUNE 18.

ZOOLOGICAL SOCIETY, at 8.30.—Observations on some Mimetic Insects and Spiders from Borneo and Singapore: R. Shelford.—Further Researches upon the Molluscs of the Great African Lakes: J. E. S. Moore. —On the Collections of Birds made by Dr. Donaldson Smith in Northern Somali-land: Dr. R. Bowdler Sharpe.

MINERALOGICAL SOCIETY, at 8.—On the Anharmonic Ratio of Four Faces in a Zone: Alfred Harker —On the Arrangement of the Chemical Atoms in Potassium-Alum and in some of the Bodies which display Tetartohedral Symmetry: William Barlow.—Remarks on Calaverite: Herbert Smith.

ROYAL STATISTICAL SOCIETY, at 5.—The Recent Gold Production of the World: Wynnard Hooper.

WEDNESDAY, JUNE 19.

GEOLOGICAL SOCIETY, at 8.—On Intrusive Tuff-like Igneous Rocks and Breccias in Ireland: J. R. Kilroe and Alexander McHenry.—The Use of a Geological Datum: Beeby Thompson.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—The Eclipse Cyclone, the Diurnal Cyclones, and the Cyclones and Anticyclones of Temperate Latitudes: H. Helm Clayton.—The Seismograph as a Sensitive Barometer: F. Napier Denison.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Examination of the Abbe Diffraction Theory of the Microscope: J. W. Gordon.

THURSDAY, JUNE 20.

ROYAL SOCIETY, at 4.30.

LINNEAN SOCIETY, at 8.—On the Freshwater Algæ of Ceylon: W. West and G. S. West.—On Coprophilous Fungi: George Massee and E. Salmon.—Revision of the Genus Hypericophyllum, Steetz, with Notes on certain Genera with which it has been confused: N. E. Brown.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Direct Union of Carbon and Hydrogen, Part II.: W. A. Bone and D. S. Jerdan. —Ammonium and other Imidosulphites: E. Divers and M. Ogawa.—Nitrilosulphates: E. Divers and T. Haga.—The Decomposition of Hydrocarbons at High Temperatures: W. A. Bone and D. S Jerdan.—The Sugars from Cellulose: H. J. H. Fenton.—On a Theory of Chemical Combination: G. Martin.—On the Occurrence of Paraffins in the Leaf of Tobacco: Dr. T. E. Thorpe, C.B., F.R.S., and John Holmes.—Studies in the Camphane Series, Part IV.: M. O. Forster.—On the Decomposition of Carbon Dioxide, when submitted to Electric Discharge at Low Pressures: Dr. J. N. Collie, F.R.S.—Two New Substances in Lemon Oil: H. E. Burgess.

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THURSDAY, JUNE 20, 1901.

CHARLES ST. JOHN.

Charles St. John's Note Books, 1846—1853, *Invererne, Nairn, Elgin*. Edited by Admiral H. C. St. John. Pp. 119. (Edinburgh: D. Douglas, 1901.) Price 7s. 6d. net.

TO many an elderly man, among whose most cherished possessions in bygone days was a well-thumbed copy of "Wild Sports in the Highlands" and who now from "life's passionless stage" looks fondly back on the imaginations of youth, "St. John" is still a magic name, awakening, like Campbell's wild flowers, forgotten affections. It brings with it a whiff of the smell of fresh trout frizzling in the mountain sheiling, blue with peat smoke, and calls up visions of misty moors and tumbling rivers, of "muckle harts," wild cats and martens, and

"Sweet little islands twice seen in their lakes,"

gardens of the Hesperides of boyish dreams.

The sportsman-naturalist was a great-great-nephew of the namesake to whom Pope dedicated his "Essay on Man," the first Lord Bolingbroke, and began life as a clerk in the Treasury. A single legend only relating to him survives in Whitehall. A warrant of some importance was wanted, and St. John's chief, remembering that not long before it had been given to him to copy, asked him for it.

The warrant was not forthcoming, and St. John, pressed to find it, with a slight stutter, not impossibly increased by a little nervousness, apologised: "I put it into the fire because it b-b-bored me."

The story may be mythical. But as, according to his own account, he "gave notice to quit to prevent a reversal of the process," it is perhaps not uncharitable to assume that he was one of His Majesty's indifferent bargains.

On leaving the Treasury he retired to a shooting property in the north of Scotland, lent him by a cousin, and shortly afterwards married a Scotch lady blessed with enough of this world's goods to enable him to enjoy to the full a life of busy idleness among red deer and salmon.

It was to a chance acquaintance with Mr. Cosmo Innes, then Sheriff of Moray, and an occasional contributor to the *Quarterly Review*, that three generations of boys are mainly indebted for "Natural History and Sport in Moray" and the yet more fascinating "Wild Sports," which has run through at least seven editions. Mr. Innes was spending an autumn holiday on a property adjoining the shooting over which St. John was privileged to wander with rod and gun. He had wounded a brace of partridges and had followed them from the island in the Findhorn where he found them to a turnip field on the opposite bank, and was looking for them when "a tall, gentlemanly man" with a poodle "with a Mephistopheles face," got over the fence and offered to find the birds which he had marked down.

Mr. Innes called in his pointers and the poodle, "with a series of curious jumps on all fours and pauses between to listen," made short work of the birds—and with this introduction a close friendship sprang up between the two men.

It was a few years later, when a day's cover shooting had been spoilt by a Highland downpour, and St. John, wrapped in a coat of sealskin of his own killing, had whiled away a long wet drive home with stories of sport and of the ways of birds and beasts he had watched, that Mr. Innes first suggested the idea that he should publish his experiences.

St. John was modest, and at first scouted the notion that he could write anything worth printing, but he mentioned "some old journals" which might, if ever the attempt were made, be useful.

The book named above contains these journals, which are now published for the first time in the form in which they were originally written, by the writer's son, Admiral St. John.

The cream of the notes was skimmed long ago for the two books which established St. John's fame, and though well worth printing, their chief interest, for those at least who are familiar with them, now lies, perhaps, in the light thrown on the secret of the fascination which—in spite of the amiable egotism which is apt at times to jar a little—those books possess.

Like White of Selborne and, on a broader canvas, Shakespeare, St. John drew direct from nature.

From a hundred pages, in almost every one of which are texts from which a naturalist might preach a sermon, it is not easy to make selections. But one or two little touches, taken almost at random, are enough to illustrate the breezy freshness of his notes.

"The tracks (of otters) which we see," he writes, "are almost invariably going up the river, showing that the animal keeps the course of the stream in her downward course; but, on coming up, frequently leaves the water to go a few yards along the bank."

Fine swimmer as she is the otter is not a salmon, above all such considerations as up stream and down stream. Again, at the same opening (p. 82),

"The bill of the oyster catcher (unlike the highly sensitive bills of ducks, woodcock and curlews, which patter or bore in the mud for small worms, &c., described a few lines earlier) is as hard as ivory at the tip, the bird using it more for breaking open shell-fish than for digging in the mud."

To give only two more quotations (pp. 74 and 86),

"Wild cats are brindled grey, and I have observed that domestic cats of that colour are more inclined to take to the woods and hunt for themselves than others."

"It blew a hurricane to-day from the W.N.W., with cold showers. . . . I saw a seagull caught by the wind in the air and turned over five or six times before it could recover its balance and get its head to windward."

Admiral St. John, before publishing his father's notes, visited again the scenes of his childhood, and has recorded his impressions in a short preface, "Moray Revisited."

Here, too, as everywhere else in the book, is food for thought for a naturalist.

Stone walls had given place to wire fences; but just where six and thirty years before, in 1851, he had found the nest of a "shoveller," a bird "not common in the locality," a shoveller with a brood of five "swam out of the tall rushes into the open water" as he walked down the river. What is the secret of the lasting attraction of certain particular spots for certain birds? The little brown-headed gulls crowd their nests, very inconveniently close together as it seems to ignorant human beings, in hundreds at one small corner only of a roomy island in Scoulton Mere, and Sheerwaters collect to breed in one only of the hundred and fifty islands of the Scilly archipelago. Guillemots, identified by peculiar egg markings, lay year after year, as Yorkshire cliff climbers agree, "within half an inch" of the same spot on the same narrow ledge.

"Water ouzels," writes St. John (p. 55), "come to the burns near the sea about the beginning of October. The same stones are occupied year after year by these birds."

In a Norfolk cover well known to the present writer, if there was a woodcock in the neighbourhood one was almost always to be found under one particular laurel bush.

Surroundings may completely change without breaking the charm. Thickknees love open spaces, and as a rule nest nowhere else. But Prof. Newton, in the article on migration in his "Dictionary of Birds," tells of their eggs laid in a thick Suffolk cover, in the precise spot where years before, when the ground was still an unplanted heath, birds of the species had been accustomed to breed.

The only thing to be objected to in an otherwise altogether charming book is the paper on which it is printed, which is abominable.

The dazzling glaze which makes reading by candlelight a pain instead of a pleasure is too high a price to pay even for St. John's spirited and witty pen and ink sketches.

If the use of the highly pressed and metallically polished papers which, since the invention of "process blocks," have become fashionable in illustrated magazines is carried much farther—the danger is very real and serious—the eyes of the rising generation will fail them long before their time.

There is something pathetic in the thought of the number of men, younger sons of country gentlemen and sons of officers, clergymen and professional men, born with the deepest-seated of aboriginal instincts—the love of sport—ingrained in their natures and brought up among birds' nests and sticklebacks, who find themselves, during the best years of their life, cut off from all that is most congenial to them and their manhood slipping from them in the close atmosphere of towns.

A writer who, like Charles St. John, can while them away from cramping surroundings and keep alive for a little longer the ever-receding dream of the good time to come some day, is not a man who has lived in vain.

T. Digby Pigott.

EXERCISES IN HYGIENE.

The Science of Hygiene: a Text-book of Laboratory Practice. By Walter C. C. Pakes, D.Ph. (Camb.), F.C.S. Pp. xv + 380. (London: Methuen and Co., 1900.)

"HITHERTO there has appeared no single text-book dealing with all the practical laboratory work which is now required from the candidate for the Diploma in Public Health." So the author writes in his preface, and the work under review is the result of his attempt to remedy what he considers to be "a great disadvantage."

When it is pointed out that in this manual some five subjects are dealt with, each of which has furnished the subject-matter of well-known text-books of similar bulk to the present volume, it is evident that Mr. Pakes's effort must partake somewhat of the nature of a cram book.

"The Science of Hygiene," we would point out, is far too pretentious a title for a small manual which at the most affords the student an incomplete digest of a very extensive branch of study. The inadequacy of treatment would be sufficiently apparent if the different kinds of subject-matter were dealt with in good proportion, but this is not so, for we find the difficult subject of vital statistics disposed of in nineteen pages, ten of which are devoted to the construction of a life table, with the result that no mention is made of one of the most important matters dealt with in vital statistics, namely, the rate of infantile mortality; the subject of physics is dismissed without any mention being made of the siphon or of the common pump, the principles of which should certainly be understood by the public health student; and the great and important matter of the chemical examination of food is dealt with in twenty-eight pages. On the other hand, the part of the work dealing with microscopy covers eighty-nine pages and is by far the most complete and best part of the book.

The work is divided into five parts. Part 1 gives an outline of bacteriology; the brief directions here given are generally sufficient if the worker has the advantage of a teacher at hand when he attempts to put them into practice, otherwise he will frequently find them insufficient. Part 2 deals with microscopy; the illustrations are for the most part good, but the representations of the starches are crude and unsatisfactory. No drawing is given of Cyclops or of Gammarus Pulex, two organisms of far more common occurrence than several of those dealt with by the writer.

In mounting the starches for microscopical examination the student is told to use a "sterilised loop" to moisten the starch with, and a further instance of carelessness is the fact that pages illustrating water sediments are headed "Internal Parasites."

Part 3, which deals with chemistry, also contains blemishes. With reference to the physical characters of water it is said that "if there is any yellowish or brownish colour there will be some suspicion of sewage contamination, unless the water happens to have been collected from a peaty soil." We should have been more disposed to warn the student that it is very rare indeed for sewage contamination, even when it is very considerable, to colour water; iron, on the other hand, is one of the more common causes of such coloration.

In the estimation of chlorides the red precipitate of chromate of silver is described as "brown." The method described for the "estimation of calcium" will include magnesium; and the "estimation of magnesium," when performed in accordance with the directions given, will lead to a very serious under-estimation.

Although the author does not offer "more than a few hints to enable those who are not adepts to avoid the many pitfalls which await them," his remarks upon the interpretation of the results of the analyses of water are faulty in places and would not be acceptable to those who are most *au courant* with this subject. There are many indefinite statements such as the following: "it may happen that a particular geological stratum contains a considerable excess of chlorine," "some geological strata contain nitrates to some considerable degree," "speaking as a rule to which there are of course notable exceptions, drinking water ought not to contain more than 0·5 part per 100,000 of nitric nitrogen."

It is said that a good deep well water often does not absorb more oxygen from the permanganate solution (in four hours at 27° C.) than 0·001 grm. per 100,000. Surely such deep well waters must be very exceptional.

A sample of upland surface water is given with 0·07 of free ammonia, 0·2 of albuminoid ammonia and 0·12 of oxygen absorbed, and with total solids amounting to 2·8 in parts per 100,000, and one of subsoil water with free ammonia 0·12, albuminoid ammonia 0·033, and oxygen absorbed 0·52, without any indication of the fact that these waters are grossly polluted.

Part 3 also deals with the analyses of sewage, sewage effluents and food. In examining sewage, the student is advised that it often happens when 10 or 20 c.c. of sewage are added to 500 c.c. of ammonia free water, that twelve or fourteen Nessler glasses of distillate are collected before the yield of albuminoid ammonia ceases. This is surely a singular experience. Working at such dilutions and under the directions given by the author, it would be extremely rare that more than five or six Nessler glasses would be required; moreover, fourteen Nessler glasses would hold 700 cubic centimetres of distillate, and how is the student to collect this from only some 500 cubic centimetres of liquid in the boiling flask?

On the subject of food analysis we are informed that analysts of repute obtain the specific gravity of milk by weighing with the specific gravity bottle. If this is so, surely there must be few analysts of repute in this country. The average amount of water in butter is put at 8·55 per cent., which is too low; and it is stated that no butter should be condemned as adulterated with water unless it contains less than 80 per cent. of fat; whereas the limit of water accepted by the Society of Public Analysts is 16 per cent. It is said that "in a normal sample of bread there is as much alum as silica," and that "the weight of silica found must therefore be deducted from the amount of alum found, and any excess will represent added alum." As a matter of fact alum is never found in pure bread, nor is it correct to state that there is as much alumina as silica in normal bread.

That the alcohol of wine and beer is determined exactly as in the case of spirits is a bald statement the insufficiency of which will be manifest to the student when, for instance, he first essays an estimation of the alcohol in beer. Doubtless by a printer's error "the Sinaitic Peninsular" is referred to on p. 152, while the atomic weight of silver is given as 107·7 on p. 191, and as 108·0 in the appendix.

It must be said, then, that the volume is on the whole an unsatisfactory one, in which most of the subjects are dealt with, not only inadequately, but sometimes faultily, owing to the attempt to compress too much matter into too small a space.

The subjects of bacteriology, public health, chemical work, physics and vital statistics have, as a matter of fact, all been dealt with in practical manuals in such a manner that the serious student will not find much use for the book under review.

PUBLIC WATER-SUPPLIES.

Public Water-Supplies: Requirements, Resources, and the Construction of Works. By F. E. Turneaure, C.E., and H. L. Russell, Ph.D. Pp. xiv+746. (New York: John Wiley and Sons, 1901. London: Chapman and Hall, Ltd.)

WATER-SUPPLY is unquestionably one of the most important branches of civil engineering in the present day, owing to the widespread nature of the demands for it, the great value attached to a pure supply, resulting from the progress of sanitary science, and the increasing difficulty, in populous countries, of obtaining an unpolluted and adequate supply. This book has been prepared with the object of supplying the needs of teachers and students in technical schools; and the greater portion of it is based on the experience of the first-named author in teaching the subject for many years, which forms one branch of his courses of lectures in the University of Wisconsin. A novel feature in this volume is the conjunction of an engineer and a chemist in its production, thereby enabling the engineering and bacteriological aspects of the question to be dealt with respectively by very competent experts; whilst a chapter on pumping machinery is contributed by another engineer. Fundamental principles have been given more prominence than details of construction, though these latter have been largely made use of to illustrate the principles involved and differences in the conditions, and a considerable space has been devoted to the quality and purification of water-supplies, constituting such important considerations from a sanitary point of view, and also to the questions connected with ground-water. The comprehensive scope of the book, and its exhaustive, though concise, treatment of the subject are most effectively illustrated by a reference to the headings of the twenty-nine chapters into which the book is divided.

The subject is opened by an introductory chapter giving a very brief historical sketch, from the earliest times, of the development of water-supplies, and a statement of the value and importance of a public water-supply for domestic, commercial and public uses. The book is then divided into two parts, the first dealing with "Requirements and Resources," and the second with "The Construction of Water-Works," in nine and nineteen chapters respectively. The first part is subdivided into two sections, with the respective headings, "Quantity of Water Required: Sources of Supply," and "Quality of Water-Supplies," occupying six and three chapters respectively. The first section comprises the quantity of water required, sources of supply, rainfall, evaporation and percolation, flow of streams, and ground-water; whilst the second section deals with the examination of water-supplies, the quality of water, and communicable diseases and water-supplies. The second part of the book, which is devoted to construction, after two introductory chapters dealing with generalities pertaining water-works construction and hydraulics, is subdivided into three sections, treating successively of works for the collection, purification and distribution of water, in six, five and six chapters respectively. The works for the collection of water comprise river and canal intakes, the collection of ground-water, impounding reservoirs, earthen dams, masonry dams, and timber, steel, and loose-rock dams; the section relating to works for the purification of water includes the objects and methods of purification, sedimentation, sand filtration, mechanical filtration and miscellaneous purification processes; and the section dealing with the distribution of water describes systems of pipes for conveying water, conduits and pipe-lines, pumping machinery, distributing and equalising reservoirs, the distributing system and operation and maintenance.

From this summary of the contents it will be seen that all the principal problems and works relating to water-supplies are duly considered in succession; whilst in several chapters the careful classification of the subjects is carried a step further, by the consideration of different branches of the subject to which the chapter is devoted, under separate headings; and the purport of every main paragraph is clearly indicated by a black-letter heading. Moreover, the descriptions are illustrated by two hundred and thirty-one figures in the text; and the quest for further information is greatly facilitated by a list at the end of each chapter of the principal publications on the special subject treated of in the chapter. Naturally, on such a subject as masonry dams, for instance, more particulars might be desired than can be compressed into twenty-two pages, especially as a considerable portion of this limited space is occupied by cross sections of notable dams; and in this case the list at the end of the chapter contains fifty-two references to books, pamphlets, and periodicals describing masonry dams, and six references in addition to failures of these dams; whilst at the end of the chapter on earthen dams there are twenty-seven references to descriptions of such dams, and eleven to their failures. The book, indeed, dwells rather upon general principles and problems than on descriptions of works, except in smaller print by way of illustration, and reliance is placed mainly on the consultation of the publications given in the list for information about details of works. A sound groundwork is presented to the student in a concise form, with reference to the considerations affecting the sources and quality of water, and the nature of the works carried out for the collection, purification, and distribution of water-supplies; and it is expected that he will add to his knowledge thus acquired by the aid of the authorities indicated, and the teachings of experience. This volume, moreover, though specially valuable to students, should also prove useful to experienced engineers, owing to the excellent classification of subjects, the amount of information collected within its pages, and the lists of publications on the various subjects; and whilst engineers will derive special benefit from the full chemical consideration of the quality of water, the diseases transmissible by it, and its purification, chemists interested in water-supplies may gain some advantage from the clear and concise explanations given of the engineering problems and works relating to water-supply.

OUR BOOK SHELF.

Leitfaden der Wetterkunde. Gemeinverständlich bearbeitet. Von Dr. R. Börnstein, Professor an der Königl. landwirthschaftlichen Hochschule zu Berlin. Pp. viii+181. (Braunschweig: Vieweg und Sohn, 1901.)

IT is one of the peculiarities of foreign countries that they have professors of meteorology in their universities and departmental colleges, and the book before us reminds us of that fact. It is a professor's book. It gives a survey of the present state of knowledge of the subject in a form suitable for presentation to a class of intelligent and educated students. The arrangement of the text is systematic and methodical, not historical. It begins with the composition of the atmosphere, and then deals with the elements of climate, namely, temperature, moisture, cloud and precipitation. Then it passes on to consider pressure and its relation to wind and weather, and concludes with an account of the weather services of different countries. It is "gemeinverständlich" in the sense that the special application of mathematics to meteorology is not treated in detail. Instruments are referred to and described, but the details of the process of observation and instructions for observers are not considered.

Within the limits indicated the work is quite successful. The most recent developments of the science are appropriately referred to. The portions dealing with thunderstorms and with weather types are especially satisfactory sections, and all the different parts are effective and concise. The more experienced students of the subject will find the references to original sources of information collected together at the end of the book especially useful. They form a short but comprehensive bibliography of the most important recent work on meteorology. They follow the arrangement of the text, but the excellent alphabetical index to the book makes it easy to look out a reference either to a subject or an author. One misses from the index the names of some prominent American meteorologists, and there are several departments of the science which are only lightly treated; but, as already stated, the book is a professor's presentation of the subject, and is not intended to be exhaustive.

The classification of clouds is the international one, under which clouds of certain types are assigned to certain limits of height. The nine plates of cloud forms are excellent reproductions from the International Cloud Atlas. In other respects also the book is well illustrated, and the print and binding are good.

Myths of Greece explained and dated. An Embalmed History from Uranus to Perseus, including the Eleusinian Mysteries and the Olympic Games. By George St. Clair. 2 vols. Pp. 796. (London: Williams and Norgate, 1901.) Price 16s.

WE do not understand what Mr. St. Clair means by an "embalmed history," and we do not think that the work which he calls by this strange title will be of the least use either to archæologists or ethnologists. Mr. St. Clair starts with the preconceived notion that all myths are of astronomical origin, and argues on the basis of this preconception, *e.g.*, p. 38, "The voyage of the Argonauts was an astronomic quest, as we must surely recognise as soon as we learn that the golden fleece which they sought belonged to the Ram of the Zodiac" (!) The rest of the book is mostly in this strain. The author cannot prove Hera, Leto, Artemis, Hades, Hephaistos or Dionysos to be astronomical, so calmly says (p. 37) "The shifting of pole and equinox and the sponging-out of constellations—which may have been required by calendar-reforms—have made the mythology to appear less astronomical than it was. . . . Most likely many of the Greek divinities may still be found in the sky, under some alias or disguise." And so forth.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Does Chemical Transformation Influence Weight?

CAREFUL experiments by Heydweiller, published in the last number of Drude's *Annalen* (vol. v. p. 394), lead their author to the conclusion that in certain cases chemical action is accompanied by a minute, but real, alteration of weight. The chemical actions here involved must be regarded as very mild ones, *e.g.* the mere dissolution of cupric sulphate in water, or the substitution of iron for copper in that salt.

The evidence for the reality of these changes, which amount to 0·2 or 0·3 mg., and are accordingly well within the powers of a good balance to demonstrate, will need careful scrutiny; but it may not be premature to consider what is involved in the acceptance of it. The first question which arises is—does the *mass* change as well as the *weight*? The affirmative answer, although perhaps not absolutely inconsistent with any well ascertained fact, will certainly be admitted with reluctance. The alternative—that mass and weight are not always in proportion—involves the conclusion, in contradiction to Newton, that the length of the seconds' pendulum at a given place depends upon the material of which the bob is composed. Newton's experiment was repeated by Bessel, who tried a number of metals, including gold, silver, lead, iron, zinc, as well as marble and quartz, and whose conclusion was that the length of the seconds' pendulum formed of these materials did not vary by one part in 60,000. At the present day it might be possible to improve even upon Bessel, or at any rate to include more diverse substances in the comparisons; but in any case the accuracy obtainable would fall much short of that realised in weighings.

As regards Heydweiller's experiments themselves, there is one suggestion which I may make as to a possible source of error. Is the chemical action sufficiently in abeyance at the time of the first weighing? If there is copper sulphate in one branch of an inverted U and water in the other, the equilibrium can hardly be complete. The water all the time tends to distil over into the salt, and any such distillation must be attended by thermal effects which would interfere with the accuracy of the weighing. RAYLEIGH.

June 11.

The National Antarctic Expedition.

IN consequence of a cable received yesterday from London, telling me that the instructions for the conduct of the Nationa Antarctic Expedition that had been passed by the Joint Committee of the Royal Society and the Royal Geographical Society have been greatly altered, I feel it my duty to resign the post of head of the civilian scientific staff of the expedition, which I had provisionally accepted. The organisation of the expedition now passed leaves the head of the civilian scientific staff nominally responsible for most of the scientific work of the expedition, but gives him no power to secure the performance of the scientific part of the programme.

The responsibility for my withdrawal at so late a date rests with those who have delayed until now the settlement of the programme and organisation of the expedition, which should both have been decided, as I understood they had been, before the ship and most of the equipment had been ordered.

I trust the protest of my withdrawal will secure to my successor more favourable conditions of work than the altered instructions would have given me.

University, Melbourne, May 4. J. W. GREGORY.

The Settlement of Solid Matter in Fresh and Salt Water.

SINCE the publication of the report of Mr. Slidell[1] on the deposits of the Mississippi delta, containing the remarkable statement that while the deposit contained in the river water of the Mississippi took from ten to fourteen days to settle, with solutions of salt, sea water or sulphuric acid the water became limpid in from fourteen to eighteen hours, it has generally been taken as an accepted fact that alluvial matter settles more rapidly in salt than in fresh water. Sir Archibald Geikie, in his "Text-book of Geology," endorses this theory; and in a recent article in the *American Engineering Magazine* on the transportation of solid matter by rivers, Mr. Starling, one of the Government river engineers, states that a small quantity of salt or other foreign material dissolved in water will diminish the suspending power and increase the rapidity of subsidence to a marked degree, sometimes even many hundred-fold.

On the face of it the result naturally expected would be, that as sea water is of greater specific gravity than fresh water, and more viscous, the grains of solid matter would sink more slowly in salt than in fresh water. The very great distance over which solid matter brought down by rivers remains in suspension after reaching the sea, extending from six miles from the mouth of the Rhone to thirty-five from the outlet of the Nile, up to 300 miles over which the sea water is stated to be discoloured by the effluent of the Amazon, appears to indicate that salt water is capable of retaining solid matter in suspension for a longer time than fresh water.

Experiments made by Mr. Vernon Harcourt with alluvial matter placed in suspension in sea water and fresh water, and in solutions containing different strengths of salt and other foreign material, although not of a conclusive character, show that there is little difference between the rate of deposit in sea or in fresh water. Of samples from different estuaries which were allowed to settle in sea water and pond water respectively, the particles of the former took about 9 per cent. more time to subside than the latter. The general conclusion he arrived at was that, though sea water promotes the deposit of "very light clayey matter contained in river silt under favourable conditions, there are no grounds for regarding it as exercising the very preponderating influence on the formation of deltas attributed to it by geologists."[1]

The writer some time ago investigated this subject in connection with researches he was then making as to alluvial deposits in estuaries, and has again more recently conducted a series of experiments the mean results of which are given in the following table:—

Table Showing Rate of Settlement of Solid Matter in Fresh and Salt Water.

No.	Number of grains to a lineal inch	Material	Time taken to settle: Fresh	Time taken to settle: Salt	Water clear: Fresh	Water clear: Salt	
			m. s.	m. s.	h. m.	h. m.	
1	100	Sand	0 10	—	—	—	Water not discoloured
2	200	do.	0 25	—	—	—	do.
3	—	Whiting ...	12 0	—	0 30	—	
4	—	Plaster of Paris	5 0	—	0 10	—	
5	300	Warp, Trent	0 43	0 45	0 1	0 1	Water scarcely discoloured
6	1400	Fine Warp, Dutch River	12 0	15 0	3 30	22 0	
7	500	Silt, Salt Marsh	2 0	2 0	0 6	0 9	
8	1000	Warp, do. ...	8 0	9 0	1 0	0 33	
9	2000	Alluvium, Boston Dock ...	33 0	28 0	7 0	1 30	
10	600	do., R. Parrett	4 0	2 40	0 15	0 18	
11	1500	do., Tilbury Bsn.	18 0	18 0	10 0	9 0	
12	1600	Brick Clay ...	17 0	15 0	1 30	1 9	

It will be seen from this table that the rate of deposit depends on the minuteness of the particles in suspension, and varies nearly in proportion as the square of the diameter of these.

With sand and silt there was practically no difference in the rate of settlement in fresh as compared with salt water. When the particles of the solid matter were very fine, as in the case of what is generally known as mud or ooze, the rate of settlement was slightly more rapid in salt than in fresh water; but there was nothing to justify the conclusion arrived at by Mr. Slidell.

All the material was first screened through a sieve having ninety meshes to the lineal inch.

The proportion by weight of solid matter to water was that which was found to exist on the average of fourteen large rivers

[1] Report on the Mississippi River by Humphreys and Abbott, 1861.

[1] "Investigation on the Action of Sea Water in Accelerating the Deposit of River Silt" (*Min. Proc. Inst. C.E.*, vol. cxlii.).

when in flood, or ·79 lb. to a cubic foot equal to 1/80th part in weight of the water in the tubes.

Both sea water and water saturated with ordinary salt were tried, the latter in the proportion of one pound of salt to a cubic foot. There was no appreciable difference between these.

The samples were placed in glass test-tubes 1 foot long and ½ inch in diameter, filled with clean water up to the ten inch mark.

The material was well shaken and incorporated with the water, and the time given for settling is that taken by the particles to settle through 10 inches and become visible in a solid form at the bottom of the tube, and when no more particles could be discerned as settling when the tube was held up to the light.

The column "water clear" is that in which the water in the tube had become sufficiently transparent for black marks on a white ground to be discerned through it.

Practically all solid matter had settled in the time given in the first column. The quantity deposited between the interval of "settling" and "clear" was almost inappreciable, but still sufficient to keep the water discoloured. With the specimens containing the coarser material the water became bright again in the time given in the second column, but with the very fine material intervals varying from two to three hours up to as many days elapsed before the water became as bright as it was before the solid matter was added, partly depending on the fineness of the material, but due more to the staining quality of some of the ingredients contained in the sample. Thus the material taken from Tilbury Dock Basin turned the water a black colour which took some time to clear. The salt water took much longer to become bright again than the fresh.

Samples were selected as fairly representing the material brought down in suspension by rivers, or eroded from the sea cliffs, and deposited either in the form of salt marshes or transported to the bed of the sea.

Thus numbers 1 and 2 represent the sand found on the foreshores of the sea coast and covered at every tide; 3 and 4, material derived from chalk cliffs; 5 and 6, the material in suspension in the rivers Ouse and Trent, of which the Warp lands bordering on those rivers are composed, 5 being the material first deposited and near the river, and 6 that further away where the water remains quiescent for some time; 7 and 8 represent the material of which salt marshes are composed, 7 being the silt deposited on the sand, and on which, when it rises to about neap tide level, 6·68 above ordnance datum, samphire begins to grow, 8 the finer warp deposited from about the level of mean high water to that of ordinary spring tides, or 10·21 to 13·34 above ordnance datum, on which salt water grass grows; 9 is alluvial matter chiefly derived from the erosion of clay banks, brought up by the tides and deposited in Boston Dock, whence it was dredged, elevated from the barges and discharged with a current of water on to low land, the sample being taken at the part furthest away from the place of deposit; 10 was taken from the "batches" on the banks of the river Parrett at about half-tide level of spring tides, or 13·67 above ordnance datum, where the finest part of the alluvium in the river settles and which is collected for making bath bricks; 11 was taken from Tilbury Dock Basin on the Thames when the water was being stirred up by the eroding pumps; 12 is from clay used for brick making; 30 per cent. of the particles of this material were from 1/800th to 1/1000th inch in diameter and the remainder smaller than this, the average size being 1/1600 of an inch.

W. H. WHEELER.

The Subjective Lowering of Pitch.

IF the subjective effect described by Mr. E. Hurren Harding (*ante*, p. 103) is of general occurrence, it is contrary to what one might expect from the observation of singers.

It is well known that persons with a good ear may sing flat, being unconscious of the defect, though they would notice it immediately in other singers. From this it seems that the singer's voice sounds *higher* to himself than to others, and yet it is *louder* to him than to any one else. Sharp-singing, on the other hand, is regarded as more indicative of a defective ear.

I have no large tuning-forks at hand, but with ordinary forks and the sound-board of a piano I find that, on bringing the ear close to the source of sound, the sense of pitch is not altered, though the elements of noise are added to the sound; and these elements consist mostly of vibrations of lower pitch, presumably the proper notes of parts of the auditory apparatus.

In connection with this subject it may be noted that, owing to the structure of the cochlea, vibrations of small amplitude affect chiefly the lower part of its spiral; and that as the amplitude increases (independently of pitch?) the concussion reaches further up the spiral, where the fibres of the basilar membrane are longer than in the lower part, and therefore more responsive to slower vibrations. F. J. ALLEN.

Malvern, June 9.

WITH reference to Mr. Harding's letter (p. 103), it would be interesting to know whether the effect he has observed with the voice, with tuning-forks and with organ pipes can also be obtained from a siren. G. W. HEMMING.

YES; such effect can be obtained from a siren. If a siren be so rotated as to give a note approximating to middle C, the note appears flattened when the ear is placed close to the instrument, such flattening being estimated by different observers (at different times) as from a semitone to a whole tone.

Normal College, Bangor. E. HURREN HARDING.

THE NATIONAL ANTARCTIC EXPEDITION.

NO answer, so far as we are aware, has appeared to Prof. Poulton's letter to the Fellows of the Royal Society on Prof. Gregory's resignation of the leadership of the scientific staff of the Antarctic expedition (of which we published a copy on May 23). We are therefore forced to conclude that the representatives of this Society on the Joint Committee are content (to use our own words) to let judgment go by default, and admit Prof. Poulton's statements to be substantially correct. Since that date, according to a second letter which we published last week, rumours have been circulated that the real cause of Prof. Gregory's resignation was not that which had been publicly stated, but domestic considerations. The dates given to Prof. Poulton's statements and extracts from letters written by Prof. Gregory (which documents we have been allowed to examine) show these rumours to be baseless, and how they have arisen is no less a mystery than that alteration in the minutes of a resolution passed by the Joint Committee on February 14, 1900, mentioned in Prof. Poulton's former letter. Prof. Gregory's position has been consistent and definite throughout. He accepted the offer of the post on certain conditions, which he believed himself (not unreasonably, in our opinion) to have made clear. On returning to England last December he found the situation had been altered. Though not liking the changes he decided to accept them, and naturally supposed when he left England last February that the arrangement, concluded the day before he sailed, would be final. On receipt of a cable message that it had been further modified (by the acceptance, in substance, of Mr. Darwin's proposition), his first impulse, as he states, when the news arrived was to send a telegram announcing his resignation; but, after reflection, he thought it wiser to await the receipt of particulars by letter. Then came the refusal of the Council of the Royal Geographical Society to accept the instructions, thus modified, the appointment of an arbitration committee, as we may call it, and their decision, which virtually endorsed the action of that Society. When Prof. Gregory was informed by telegraph of the last step he at once cabled his resignation. We do not see how he could have done otherwise. There was now, to use his own words, "no guarantee to prevent the scientific work from being subordinated to naval adventure, an object admirable in itself, but not the one for which I understood this expedition to be organised."

Prof. Gregory, some experts have pleaded, is unreasonable in his expectations; the rules of the Service necessitate the complete autocracy of the naval officer in command. We content ourselves with the reply that if this be so it is only one more instance of the deleterious effect of red tape in this country, of which we have just received, in the case of the War Office, so impressive, we may say so humiliating, a lesson. Others may ask: Why could not Prof. Gregory have shown a more trustful spirit and sailed in the *Discovery*, believing all things and hoping all things? There are limits even to faith. Had the commander of the expedition been a man distinctly his senior, already accustomed to scientific voyages, with some experience of polar exploration and those special problems which may be solved by the Antarctic expedition, Prof. Gregory might have ventured to dispense with securities and to feel confident that the interests of science would not be subordinated to the more showy work of adding new capes and islands to the map. But is this the case? The commander of the *Discovery*, we are informed, was, not many months ago, torpedo-lieutenant on a man-of-war, has had no experience in either Arctic or Antarctic seas, is no doubt well versed in those subjects of which a knowledge was demanded by his former post, may possibly be thoroughly competent to direct magnetic observations, but he has not as yet won the slightest reputation as a naturalist, a geologist, or an investigator of glacial problems. The last two qualifications are of exceptional importance in this expedition. They cannot be acquired on the voyage out, even by the help of a tutor; they demand, not only book learning, but also much practical experience. This Prof. Gregory possesses in an exceptional degree. He knows where a search for fossils will be the most hopeful and what will be of most value to palæontologists. He has mastered the literature of glacial questions, and he has studied glaciers themselves, in the Alps, Spitsbergen and elsewhere. He has travelled much, and on his notable expedition to Mount Kenya displayed powers of organisation, calmness in critical circumstances, physical endurance and moral courage which gave him at once a high place among explorers. He has a reputation to lose. Can he be expected to imperil that by absolute surrender to one who is probably his junior and is without experience in the branches of science of which he is a master? As Prof. Gregory truly remarks: "The position gives no power to secure a fair opportunity for work to the man who would have to bear the blame for scientific failure." It was not the position which he had originally consented to accept, it was not that which was agreed upon when he left England last February; so, perceiving that he was no longer supported by those whom he had regarded as representing the interests of science, he promptly withdrew from an untenable position.

The action of those representatives (or rather the majority of them) is inexplicable. They have worked, we hear it said, in the interests of peace. But there are occasions when even peace may be too dearly bought. "There must be give and take," one of them pleaded at a notable crisis. Certainly, but it has been all give on the one side and all take on the other. "The Council of the Royal Geographical Society," it was urged, "were acting within their rights when they rejected the instructions, as modified by their secretary." Certainly, so is one nation doing when it breaks off diplomatic relations with another, and in this way their action should have been regarded by the Council of the Royal Society. That body, or its representatives, seem to have adopted, at least during the present year, "a peace at any price" policy. In consenting to the appointment of a committee of arbitration they meekly accepted a snub, and in designating its members they exposed themselves to defeat. We have the highest respect for their nominees individually, but not one of them is a recognised expert in those branches of science the interests of which were most at stake. The other half of the court consisted of geographers—that is, of men who were really counsel for that side—and yet this court called no scientific experts to plead before it, though this had been virtually promised, but promptly gave its decision. Time would be saved if this practice were imitated in our law courts, but whether justice would be promoted is another question.

It has, however, been asserted that the Royal Geographical Society ought to be allowed a preponderant influence in the organisation of this expedition, because it had provided, directly or indirectly, most of the funds. This difficulty, however, is so obvious that it should have been foreseen at the outset, and the Royal Society have been careful to protect itself from being forced into a false position by inequality of contribution.

But we may go on to ask, does the Royal Geographical Society flatter itself that the Government would have made that grant of 45,000*l*. if its application had not been so energetically and heartily supported by the Royal Society? We venture to be sceptical on this point, and so to affirm that it was the duty of the latter body, at any rate after the rejection of the amended instructions by the Council of the Royal Geographical Society, to have announced that, while wishing all success to the Antarctic expedition, it could no longer be responsible for the guidance of its scientific work or the expenditure of public money. Now it must be content to follow whither the geographers lead. It will receive little honour for any successes, but will have to bear much of the blame if the scientific results are of small value. Its representatives have not afforded, as Prof. Poulton complained, to "the claims of the scientific chief in an expedition undertaken to do scientific work . . . that unflinching, undivided and resolute support" which not only he, but also those who set science above even geographical exploration, had expected and desired.

THE TELEGRAPHONE.

A DESCRIPTION of the telegraphone—the remarkable recording telephone invented by Herr Poulsen—was given in these columns in August last (vol. lxii. p. 371). At that time the instrument was on view at the Paris Exhibition, and though we were able the explain the principle upon which it was designed we could give no detailed description of the actual instrument, nor had we ourselves been able to test its powers. Since then it has been brought to England and has been exhibited at the Royal Society and at other places, where it has deservedly attracted a very large amount of attention. A further description may, therefore, in the circumstances be acceptable.

Herr Poulsen's invention fully deserves to be called one of the most astonishing that have been made of late years. That the delicate vibrations of the human voice could be changed into variations of an electric current and thus be transmitted over a distance and reproduced at the far end came as a surprise to men of science a quarter of a century ago. With no less surprise do we learn today that these telephonic currents, small though they are, can yet be used to create permanent magnetic fields in a steel wire, which will thus be made to serve as a tablet on which to write one's speech. It is not to be wondered at that when first Herr Poulsen's discovery was announced many were incredulous as to its genuineness; the invention is precisely of the kind that one does not believe could be practical until one has actually seen or heard it in operation. That it will have the effect of putting the phonograph on an entirely new basis no one who has heard it can doubt. The speech reproduced by the telegraphone is almost as much superior to that reproduced by the wax cylinder phonograph as are the living pictures of the kinematograph to those of the zoetrope. There is none of the very unpleasant twang inseparable from the ordinary phonograph ; the speech is as clear and distinct as that transmitted through a good telephone.

In Fig. 1 is shown a photograph of one form of the telegraphone, in which the steel wire that is intended to receive the record is wound in a spiral on a drum, this drum being rotated either by a small motor or by hand, as shown. The little magnet which imprints the records on the wire is seen on the front of the drum with the wires leading from it to the transmitting or receiving telephone. The magnet is mounted on a small carriage, which slides on a bar going from right to left of the instrument at the top. At the back, attached to the same carriage, is a small plough, which engages with the steel wire on the drum and thus acts as a guide. When it is desired to speak to the instrument the magnet is started at the right hand side and the plough made to engage with the wire. The drum is then rotated, and as it turns the magnet moves from right to left, the wire passing all the time between its poles. During this motion any words spoken into a telephone connected to the magnet will be recorded as a series of magnetic fields on the wire. When the magnet arrives at the end of the wire the mechanical trip on the left of the instrument lifts the plough off the recording wire and makes it engage with a wire wound in a wide helix, which can be seen at the back; this causes the carriage and magnet to return quickly to the starting point. To reproduce the record the magnet is connected to a telephone receiver and is again made to travel along the spiral ; as the now magnetised wire passes between its poles it sets up currents which reproduce the recorded speech in the receiver.

The record can be left on the wire and used over and over again ; it is not certain how long the record will last, as sufficient time has not yet elapsed to test this point. We heard a song in Danish which had been sung to one of these instruments some months ago, before it was taken away from Copenhagen ; though the song had been repeated a very great number of times it still seemed very distinct, though, being in Danish, we cannot venture to express any opinion on the articulation. If, however, it be desired to wipe out the record, a steady current is passed through the magnet coils as it travels from end to end of the recording wire ; this effectually destroys all the existing record and leaves the wire ready to receive a fresh one. This form of instrument is comparable to the ordinary phonograph in that it can only receive a record of one or two minutes' duration ; but, quite apart from its greater clearness, it is superior to the phonograph because the records can be so easily wiped out and fresh ones made.

Another form of telegraphone is shown in Fig. 2. In this a steel ribbon is used instead of a wire to receive the record. The ribbon is wound on two drums so that it can be unrolled from one on to the other. As it goes from one drum to the other it passes over the poles of the recording magnet, which is connected, as before, with the telephone receiver or transmitter. It is remarkable that although the convolutions of the ribbon when wound on the drums lie closely one above the other, the magnetic fields on one turn do not seem to interfere with those on another. With this arrangement it is easily possible to cut off any length of ribbon holding a particular record which it is desired to preserve.

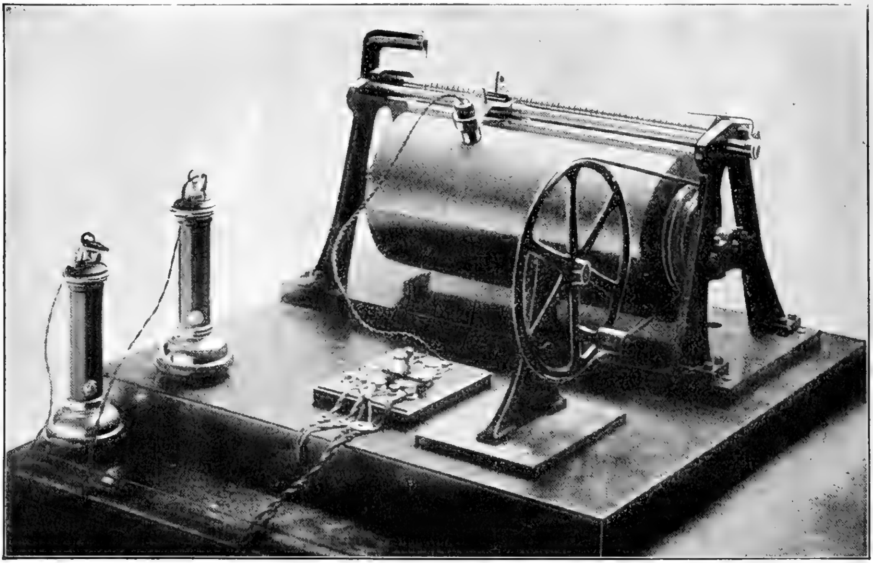


Fig. 1.—Steel Wire Telegraphone (From the *Electrician*.)

A very ingenious apparatus has been devised by which a message may be transmitted simultaneously to any number of stations, an arrangement which should prove very useful for many purposes, for example for Press messages, &c. A diagram of this apparatus is shown in Fig. 3. An endless steel ribbon, R, passes round two pulleys, A and B, driven by a motor. This ribbon, after it leaves the pulley, A, comes to a strong permanent magnet, P, which wipes out any record existing on it. It then comes to a magnet, M, connected with the microphone transmitter, and from this it receives a record of any words spoken. The ribbon, now carrying a record, next comes to a series of magnets, M_1, M_2, M_3 . . . each of which is connected to a different circuit. The message is thus transmitted by the magnets, M_1, M_2 . . . to any number of distant stations at the same, or practically the same, moment. The ribbon after leaving the last magnet comes round again

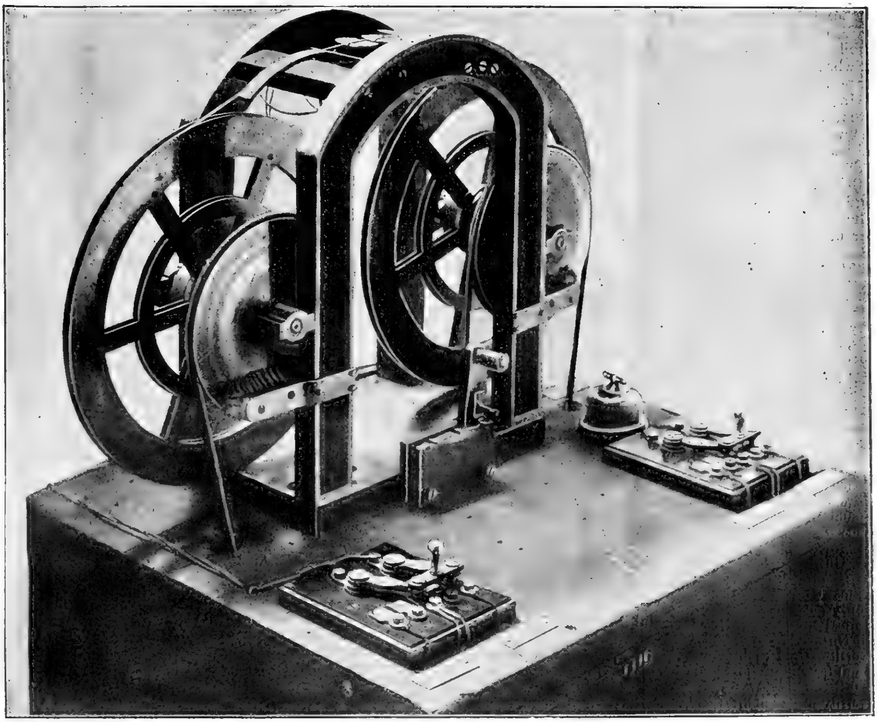


FIG. 2.—Steel Ribbon Telegraphone. (From the *Electrician*.)

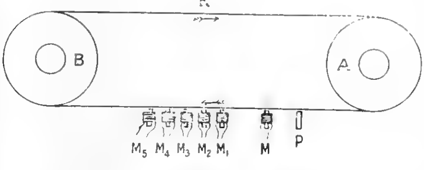


FIG. 3.—Distributing Telegraphone.

in due course to the permanent magnet, P, by which it is cleaned to receive fresh magnetisation; thus messages of any length can be sent by this means.

From this arrangement is derived the telephonic relay to which we referred in our last article. Let the series of magnets M_1, M_2 . . . instead of being connected to distant receiving telephones be connected to a series of recording magnets which are used to produce records on a number of steel tapes. If all these steel tapes be made to repeat their record at the same instant to a single receiving telephone the loudness of the speech will be increased in proportion to the number of ribbons used.

We understand that successful experiments have been carried out on these lines, but that no actual relay has as yet been constructed. It is to be noted that as the energy is derived from the motion of the ribbons, and therefore from the motor used to drive them, there is theoretically no limit to the loudness that could be attained. If Herr Poulsen is really successful in constructing a telephonic relay, as there seems to be every prospect of his being, he will have accomplished a feat of immensely greater importance than the invention of an improved phonograph, or even of a satisfactory recording telephone. So far as this last point is concerned we learn that very successful trials have been carried out in America between Boston and New York. The ordinary telephone lines were used, the telegraphone being substituted for the receiver at one end; a good and clear record of the transmitted speech is said to have been obtained.

THE NINTH JUBILEE OF GLASGOW UNIVERSITY.

THE ninth jubilee of the University of Glasgow was celebrated last week with brilliant ceremony. The proceedings opened on Wednesday with a commemoration service in Glasgow Cathedral, when a sermon was preached by Dr. M'Adam Muir. In the afternoon Principal Story, the Vice-Chancellor, on taking the chair, read the following telegram from the King:—"I remember with what great pleasure I laid the foundation stone of your new buildings in 1866, and I heartily congratulate the University on the celebration of the 450th year of its existence." He then addressed a welcome to the delegates, who subsequently presented addresses from universities, colleges and other learned and public bodies on the Continent, in the United States of America, the British colonies and dependencies, and the United Kingdom.

The foreign institutions represented, in alphabetical order of countries, were as follows:—

Austria-Hungary: Universities of Cracow, Klausenburg, Lemberg, Prague and Vienna. *Belgium:* Free University of Brussels, Royal Academy of Science, Letters and Art, University of Liège, and Catholic University of Louvain. *Finland:* University of Helsingfors. *France:* Universities of Caen, Lille, Lyons, Aix-Marseilles, Montpellier, Paris and Rennes, Academy of Medicine, Institute of France, and Franco-Scottish Society. *Germany:* Universities of Breslau, Göttingen, Heidelberg, Kiel and Leipzig, and Royal Society of Sciences, Göttingen. *Holland:* Royal Academy of Sciences, and University of Utrecht. *Italy:* Universities of Bologna, Padua, Rome and Turin, Royal Academy of Sciences, Bologna, Royal Society of Naples, Italian Society of Science, Royal Academy of Sciences, Turin, and Royal Institute of Science, Letters and Art, Venice. *Japan:* University of Tokio. *Norway:* University of Christiania. *Portugal:* University of Coimbra. *Russia:* Universities of Kieff and Moscow, Imperial Society of Naturalists, and Imperial Military Academy of Medicine. *Spain:* University of Zaragoza. *Sweden:* Universities of Lund and Upsala. *Switzerland:* Universities of Bern, Geneva, Lausanne and Neuchatel. *United States of America:* University of Michigan, Johns Hopkins University, University of California, University of Boston, American Academy of Arts and Sciences, Massachusetts Historical Society, University of Chicago, University of Missouri, North-Western University, Dartmouth College, Cornell University, University of Wisconsin, Yale University, American Oriental Society, Columbia University, New York, Union Theological Seminary, New York, Leland Stanford Junior University, University of Pennsylvania, American Philosophical Society, Historical Society of Pennsylvania, Princeton University, Cooper Medical College, Columbian University, National Academy of Sciences, Smithsonian Institution, Clark University, American Philological Association, Archæological Institute of America, and Smith College.

The institutions in British Colonies and Dependencies represented at the celebration were:—

Australia: Universities of Adelaide, Melbourne and Sydney. *Canada:* Dalhousie University, Queen's College, Kingston, M'Gill University, and the University of Toronto. *India:* Universities of Allahabad, Bombay, Calcutta, Lahore (Punjab University) and Madras, and Asiatic Society of Bengal. *New Zealand:* University College, Auckland.

On the morning of Thursday there was a crowded attendance in the Bute Hall of the University to hear an oration on James Watt by Lord Kelvin, and another by Prof. Smart on Adam Smith, and to see the graduation ceremony at the conclusion of the addresses.

Lord Kelvin described Watt's career and achievements in an address of which the following is an abstract:—

The name of James Watt was famous throughout the whole world, in every part of which his great work had conferred benefits on mankind in continually increasing volume up to the present day. It was fitting that the University of Glasgow, in this celebration of its ninth jubilee, should recollect with pride the privilege it happily exercised 145 years ago of lending a helping hand and giving a workshop within its walls to a young man of no University education, struggling to begin earning a livelihood as a mathematical instrument maker, in whom was then discovered something of the genius destined for such great things in the future. In a note by Watt appended to Prof. Robison's dissertation on steam engines, he said that his attention was first directed in the year 1759 to the subject of steam engines by the late Dr. Robison, then a student in the University of Glasgow and nearly of his own age. He at that time threw out an idea of applying the power of the steam engine to the moving of wheel carriages and to other purposes, but the scheme was not matured, and was soon abandoned. On his going abroad about the year 1761 or 1762, Watt tried some experiments on the force of steam in a Papin's digester, and formed a species of steam engine by fixing upon it a syringe one-third of an inch diameter with a solid piston, and furnished also with a cock to admit the steam from the digester or shut it off at pleasure, as well as to open a communication from the inside of the syringe to the open air, by which the steam contained in the syringe might escape. That single acting, high-pressure syringe engine, made and experimented on by James Watt 140 years ago in his Glasgow College workshop, now in 1901, with the addition of a surface condenser cooled by air to receive the waste steam and a pump to return the water thence to the boiler, constituted the common road motor, which, in the opinion of many good judges, was the most successful of all the different forms tried within the last few years. Watt left Glasgow in 1774 to live in the neighbourhood of Dr. Erasmus Darwin, grandfather of Charles Darwin. But Greenock and the University and City of Glasgow never lost James Watt. The University conferred the honorary degree of LL.D. upon him in 1806. In 1808 he founded the Watt Prize in Glasgow College. He became Fellow of the Royal Society of Edinburgh in 1784, Fellow of the Royal Society of London in 1785, correspondent of the French Academy of Sciences in 1808, one of the eight "Associés Etrangers" of the French Academy of Sciences in 1814. Lord Kelvin did not know if any University in the world ever had a tradesman's workshop and saleshop within its walls, even for the making and selling of mathematical instruments, prior to 1757. But whether the University of Glasgow was or was not unique in its beneficent infraction of usage in this respect, it was certainly unique in being the first British University—perhaps the first University in the world—to have an engineering school and professorship of engineering. This began under Prof. Lewis Gordon about 1843. Glasgow was certainly the first University to have a chemical teaching laboratory for students started by its first professor of chemistry, Thomas Thomson, some time between 1818 and 1830. Glasgow was also certainly the first University to have a physical laboratory for the exercise and instruction of students' experimental work, which grew up with very imperfect appliances between 1846 and 1856. Pioneer though it was in those three departments, it had been outstripped within the last ten or fifteen years by other Universities and colleges in the elaborate buildings and instruments now needed to work effectively for the increase of knowledge by experimental research and the practical instruction of students. But there was no lagging to-day in the resolution to improve to the utmost in all affairs of practical importance, and they almost saw attainment of the further aspirations to excel over all others in the magnificent James Watt Engineering Laboratory of the University of Glasgow to be ready for work before the expected meeting of the Engineering Congress next September. Now, through the magnificently generous kindness of Mr. Andrew Carnegie to the people among whom he has made for himself a summer home in the land of his birth, all the four Scottish Universities could look forward to a largely increased power of benefiting the world by scientific research and by extending their teaching to young people chosen from every class of society as likely to be made better and happier and more useful to our country by University education.

The honorary degrees were afterwards conferred. The list was by far the longest that has ever been submitted at any graduation ceremony at the University. It included 22 Doctors of Divinity and no fewer than 120

Doctors of Laws, including several ladies. This is the first instance of the bestowal by the University of honorary degrees upon ladies.

The new botanical department of the University was opened by Sir Joseph Hooker on Thursday in the presence of a distinguished company. Sir Joseph Hooker prefaced the ceremony with a description of the work done by his father both before and after he became professor of botany in the University in the first quarter of last century. He had not been educated for the medical, or, indeed, any other learned profession. Having inherited ample means and having been from childhood devoted to the study and collection of objects of natural history, he determined to devote his life and his fortune to travel and scientific pursuits. Early in 1820, reduced circumstances requiring him to turn his botanical attainments to material account, he obtained, through the influence of his friend Sir Joseph Banks with George III., the chair of Regius Professor of Botany in this University. It was a bold venture for him to undertake so responsible an office, for he had never lectured, or even attended a course of lectures, and in Glasgow, as in all other Universities in the kingdom, the botanical chair was, and had always been, held by a graduate in medicine. Owing to these disqualifications his appointment was naturally unfavourably viewed by the medical faculty of the University. But he had resources that enabled him to overcome all obstacles—familiarity with his subject, devotion to its study, energy, eloquence, a commanding presence, with urbanity of manners, and, above all, the art of making the student love the science he taught. Continuing, Sir Joseph Hooker said :—

If I were asked what I regarded as of most importance to the student in the manner of my father's teaching I would answer that it taught the art of exact observation and reasoning therefrom, a schooling of inestimable value for the medical man, and one that is given in no other profession, but which ought to come, in this country, as it does in Germany, early in the education of every child. I have met many of my father's pupils abroad, in India and the Colonies, who have told me that these botanical lectures gave them the first ideas they had ever entertained of there being a natural classification of the members of the vegetable kingdom. Then with regard to the results in a botanical point of view, the magnetism of the lecturer and the interest of the subject imbued many of his pupils with a love of science that proved permanent and fruitful. They made observations and collections for their quondam professor in the temperate and tropical climates of both hemispheres, some of them throughout their lives, which have very largely contributed to a knowledge of the flora and vegetable resources of the globe. After twenty years of professorship my father retired, and undertook the directorship of the Royal Gardens, Kew. Since that period great changes have been introduced in the method of botanical teaching in all our Universities, due, on the one hand, to a vastly advanced comprehension of the structure of plants and of the functions of their organs, and, on the other, to a recognition of the fact that the study of the animal and vegetable kingdoms cannot be considered apart. Furthermore, chemistry, physics and greatly improved microscopes are now necessary for the elucidation of the elementary problems of plant life. The instruction in these two sciences (chemistry and physics) has with all others advanced in this University *pari passu* with that of botany, and kept it in the forefront of the educational establishments of the kingdom. The addition of the building in which we are assembled is evidence of the resolve that it shall not relax its efforts to maintain its well-earned position, and with the conviction that the botanical laboratory will prove an invaluable aid to research under the ægis of its distinguished director, I now, under his authority, declare it open.

The official celebration of the jubilee was brought to a close on Friday, when an oration on William Hunter, by Prof. Young, was read by Prof. Bower in the Bute Hall.

NOTES.

THE late Prof. G. F. Fitzgerald was so highly esteemed in the world of science that a movement to establish a memorial of his greatness will certainly meet with ready and liberal support. It is proposed to found a "Fitzgerald Research Scholarship," to be awarded annually at Trinity College, Dublin; and a large and influential committee of leaders of science at home and abroad has been formed to obtain funds for this purpose. The object is one which would have had the entire approval of Prof. Fitzgerald, whose chief care was the encouragement of experimental research in the laboratories entrusted to his guidance at Trinity College. The scholarship would be attached to the department of experimental physics in the College, and would enable promising students to pursue investigations which, for want of means of immediate support, might otherwise have to be relinquished. Prof. Fitzgerald's marvellous faculties and noble character are so well known and appreciated among scientific men that it is almost unnecessary to urge the claims of the object to their attention. We have confidence that the response to the appeal for funds will be sufficient to provide an adequate endowment for the scholarship it is desired to establish. Subscriptions should be sent to one of the honorary treasurers, Prof. D. J. Cunningham, F.R.S., or Dr. H. H. Dixon, Trinity College, Dublin.

A COMMITTEE has recently been appointed by the Institution of Civil Engineers, with the support of the Institutions of Mechanical Engineers and Naval Architects and of the Iron and Steel Institute, to consider the advisability of standardising the various kinds of iron and steel sections, and, if found advisable, then to consider and report as to the steps which should be taken to carry such standardisation into practice. The committee is composed as follows:—Mr. James Mansergh, Sir Benjamin Baker, K.C.M.G., Sir John Wolfe Barry, K.C.B., Sir Frederick Bramwell, Bart., Sir Douglas Fox, Mr. G. Ainsworth, Mr. William Dean, Mr. A. Denny, Mr. J. Allen McDonald, Mr. E. Windsor Richards, Mr. James Riley, Prof. W. C. Unwin, F.R.S., and Dr. J. H. T. Tudsbery (hon. secretary). Mr. Leslie S. Robertson, of 28, Victoria Street, S.W., has been appointed secretary to this committee, which has already commenced its work by taking evidence tendered by engineers, manufacturers and contractors bearing upon the subject of the inquiry.

THE Société des Amis des Sciences physiques et mathematiques at Poltava, Russia, is making arrangements to celebrate the centenary of the birth of Michel Ostrogradsky at Poltava on September 12-25 next.

THE following gentlemen have been elected to fill up vacancies in the list of foreign members of the London Mathematical Society:—Prof. Ulisse Dini, Pisa; Prof. Georg Cantor, Halle-a-Saale; and Prof. David Hilbert, Göttingen.

THE Berlin correspondent of the *Times* announces that an office has been opened in Berlin in order to co-operate in the preparation of an international catalogue of scientific literature. Dr. Oscar Uhlworm, chief Royal librarian, has been appointed to direct the work of the office.

THE Royal Horticultural Society will hold an exhibition of lilies at their Chiswick Garden, on Tuesday and Wednesday, July 16 and 17. On July 16 a conference on lilies will also take place in the Garden. The chair will be taken by Mr. H. J. Elwes, F.R.S., who will deliver an opening address on lilies discovered or brought into cultivation since the issue of his monograph on the subject.

THE fifth malarial expedition of the Liverpool School of Tropical Medicine, consisting of Major Ronald Ross, F.R.S., and Dr. Logan Taylor, left Liverpool for Freetown, Sierra Leone, on Saturday morning in the steamship *Axim*. It is proposed to attempt the extermination of the Anopheles mosquito on the West African Coast. The expedition has been equipped, free of expense, with large quantities of cement, petroleum, creosote and other means of attacking the Anopheles' breeding-grounds. The most dangerous time of the year, when the rainy season is at its worst, has been chosen as the most likely to test the efficacy of the intended operations.

AT a meeting of the subscribers to the Symons Memorial Fund, held on Tuesday, June 11, the executive committee reported that the proposal that the memorial to Mr. G. J. Symons, F.R.S., should take the form of a gold medal had been approved, and that the sum of 713*l.* 14*s.* 7*d.* had been subscribed for that purpose. After paying for the dies for the medal and the expenses of printing and postage, there remained a balance of 621*l.* 14*s.* 4*d.*, which the treasurer was instructed to hand over to the Royal Meteorological Society for the interest on the same to be used for the awards of the medal. It was resolved that the medal should be awarded biennially for distinguished work done in connection with meteorological science, irrespective of sex or nationality.

AT the summer meeting of the Institution of Naval Architects, to be held at Glasgow on June 25-27, Lord Glasgow, president of the Institution, will occupy the chair. Among the papers to be read are:—"On the Limit of Economical Speed of Ships," by Mr. E. T. D'Eyncourt; "On Screw Propellers" (abstracts of two papers by M. Drzewiecki); and "The Adoption of a Rational System of Units in Questions of Naval Construction," by M. Hauser, chief engineer in the French Navy (retired). The dinner of the Institution will be held on June 26 in the grounds of the Glasgow Exhibition, and will only be open to members and the official guests. The festivities include a conversazione at the invitation of the Lord Provost and the Corporation, a garden party at Kelburne, Lord Glasgow's seat, a reception at the University at the invitation of Principal Story and the Senate, and a cruise on the Firth of Clyde.

WE are indebted to *Science* for the following items of news:—Prof. Ira Remsen, professor of chemistry in the Johns Hopkins University since its foundation in 1876, has been elected president of the University.—A committee consisting of Prof. Ira Remsen, J. S. Ames and W. H. Welch has been appointed to arrange a memorial to the late Prof. Henry A. Rowland.—It is announced that Mr. John D. Rockefeller has given 200,000 dollars for the foundation of an institute for medical research, and it is understood that this fund will be increased as needed. At present America lacks an institution corresponding to the Pasteur Institute in Paris or the Jenner Institute in London. It appears that this need will be met by Mr. Rockefeller's gift, though the exact scope of the institution is still under consideration.

THE Council of the Society of Arts attended on Friday last at Marlborough House to present the King with the Albert medal of the society, which, as already announced, had been awarded to His Majesty "in recognition of the aid rendered by His Majesty to arts, manufactures and commerce during thirty-eight years' presidency of the Society of Arts, by undertaking the direction of important exhibitions in this country and the executive control of British representation at international exhibitions abroad, and also by many other services to the cause of British industry." The King said that he accepted the interesting medal, founded in memory of his lamented father, with much pleasure, because, during his long association with the Society of Arts as its president he had always taken a warm interest in its proceedings and its success. A special reason which enhanced the gratification with which he accepted the medal was that not many years ago he had himself, as president of the Society, presented it to his beloved mother, her late Majesty Queen Victoria. His Majesty added that, although he had retired from the active duties of the presidentship, he would continue to take a warm interest in the Society as its patron.

PROF. RAY LANKESTER has now received the case shipped at Mombasa on April 19, containing the skin and two skulls of the remarkable new giraffe-like animal obtained from the Semliki forest by Sir Harry Johnston, and sent by him for preservation in the Natural History Department of the British Museum. Writing to the *Times* with reference to the specimens, Prof. Lankester says: "The animal is a giraffe-like creature devoid of horns, with relatively short neck and with colour stripes on the limbs, but nowhere showing spots or areolæ like those of the giraffe. Sir Harry Johnston was amply justified in assimilating the animal to the extinct Helladotherium, but after an examination of the skulls I am of opinion that the 'Okapi' (the native name by which the new animal is known) cannot be referred to the genus of the Helladotherium, but must be placed in a new genus. I must say that, although the horny hoofs are not present, yet the double bony supports of the hoofs are preserved with the skin, and leave no doubt, even without reference to the accompanying skulls, that the animal which bore the skin was not a horse-like creature, but one with cloven hoofs."

IT is proposed to hold an exhibition on an extensive scale at Bendigo at the end of this year, under the auspices of the Government of Victoria, to commemorate the discovery of gold in 1851, and to celebrate the jubilee in a manner that will rank as a fitting memorial of the first anniversary of the Australian Commonwealth. Prominence will be given to the gold-mining and other mineral resources, and phases of mining in Victoria and other States, and special courts will be erected for the display of manufactures and industries, wool, agriculture, dairying machinery, &c. The Bendigo School of Mines will provide a model laboratory for the Exhibition, equipped with furnaces and apparatus for metallurgical and chemical work. There will be five main divisions of the exhibits and twenty-five sections, in which the applications of science to mining and to the development of other natural resources will be well represented.

DURING the past week the use of wireless telegraphy upon ocean liners has been satisfactorily demonstrated. A series of messages were despatched and received by passengers on the Cunard liner *Lucania*, which sailed from Liverpool on Saturday, and also by passengers on the Elder Dempster liner *Lake Champlain*, which reached the Mersey from Montreal on Monday afternoon. Stations have been established by the Marconi Company in connection with the Post Office wires, so that telegraphic messages can be received or despatched by passengers *en voyage*, the communication between the station and the vessel being by wireless telegraphy. The number of these stations is, as yet, not large, but there are enough of them to enable communication to be maintained, though with considerable intervals, from the time the vessel leaves Liverpool till she is an hour or so past the Fastnet. While in the Mersey she can speak with the training-ship *Conway*. As she steams along the north coast of Wales she gradually becomes within range of the station at Holyhead, which is about sixty-four miles from Liverpool. The next station is at Rosslare, in the south-east corner of Ireland, about ninety miles from Holyhead, and the last station is Crookhaven. Homeward bound vessels can pick up the stations in the reverse order. On Monday communication was established with Crookhaven by the *Lake Champlain*, and numerous service and private telegrams were despatched notifying the steamer's safe arrival off Ireland. The next station communicated with was Rosslare when forty-five miles distant. For more than five hours there was a continuous stream of messages, upwards of fifty being sent. Communication was next established with Holyhead, greetings being interchanged at a distance of 33½ miles. When 37¾ miles from Liverpool a message was received from the owners and orders were despatched instructing the captain to disembark passengers at the Princes' landing stage.

A SERIES of fine radiographs obtained by Dr. G. H. Rodman, of East Sheen, has been sent to us by Messrs. Cox and Co.; and as we admire the minute details shown by them, we appreciate the remarkable advances made in Röntgen ray photography since the first pictures were obtained six years ago.

1 Ampullaria. 2 Murex. 3 Eburna.
4 Cassis. 5 Struthiolaria. 6 Dolium (young).
7 Turritella. 8 Bulla. 9 Voluta.

Four years ago a series of radiographs of all the British batrachians and reptiles was prepared by Messrs. Green and Gardiner and published. The application of Röntgen rays to biological study was well exemplified by these pictures, and also by radiographs of molluscs obtained later by the same observers, one of an entire Nautilus and another of an entire Chiton being particularly memorable. The uses of radiography to the study of the shells of the Mollusca are, however, not so well known as they deserve to be, and we are glad to direct attention to the accompanying pictures obtained by Dr. Rodman. The correct systematic position of many forms depends on the presence or absence of certain plaits, or folds, or tooth-like projections, either on the central shelly pillar (columella) or on the inner sides of the outer wall of the shell. These are frequently so situated as to be invisible through the aperture, and when only a single specimen may be available, which it is undesirable to sacrifice in the cause of science, the utility of radiography in this connection at once becomes apparent. The evidence of the accidental inclusion of a smaller shell (it is too large for an embryo) in No. 7 is noteworthy. Radiography may also be able to determine the mineral condition of the shell, whether the carbonate of lime in its substance takes the form of calcite or arragonite, or of the one in the young and the other in the older shell, as would almost seem to be the case in No. 7. On this point, however, further research is necessary. In the case of the recent Nautilus shell, the Röntgen process shows the details of every septum and the siphuncle with great clearness, as may be seen by reference to plate xv. of vol. xi. of the *Proceedings* of the Malacological Society of London. For the benefit of those who may wish to emulate Dr. Rodman, we may add that the exposure employed by him was 80 seconds at a distance of 11 inches on an Imperial Special Rapid plate, using a Cox 10-inch spark coil and their "Record" focus tube. This is the tube which has just been awarded the gold medal given by the president of the Röntgen Society, Dr. John Macintyre.

WE have received from the president of the International Aëronautical Committee a preliminary account of the balloon ascents on May 14. Eighteen ascents took place, including manned and unmanned balloons, of which six were at Berlin, four at Strassburg and three at Vienna. Two of the unmanned balloons have not yet been found. The highest altitudes were reached by the French balloons. One of these ascents, made from Chalais-Meudon, was particularly interesting: at starting the temperature was 15°·8 C., zero was recorded at 3661 m., −50° at 9640 m., and the lowest temperature, −55°·8, at 11,025 m.; but an inversion of temperature afterwards occurred, and on reaching the greatest altitude, 15,414 m., the thermometer had risen to −32°·2. Two balloons were sent up from Trappes (near Paris): one at 2h. 30m. a.m., which recorded 0° at 2740 m. and −64° at 11,400 m.; the other, at 8h. a.m., recorded zero at 2900 m. and −60° at 11,200 m. On this occasion no balloon was sent up by this country.

THE new standard pentane ten-candle-power lamp and the new form of photometer, prescribed for use in the official gas testing-stations in London, were described by Prof. Frank Clowes at a meeting of the Incorporated Gas Institute on Wednesday, June 12. The source of light in the new lamp is the flame produced by burning, under suitable and definitely prescribed conditions, a stream of carburetted air. The carburetting liquid is the light petroleum known under the chemical name of pentane. The liquid pentane evaporates rapidly at ordinary atmospheric temperatures, and the vapour which it produces is rather more than two and a half times as heavy as atmospheric air. As the name of the lamp implies, its flame has been shown to give under prescribed conditions a constant illumination equal to that furnished by ten standard candles. The new photometer differs in its arrangement from the bar-photometers which were previously in use in the fact that the flames under comparison are upon one side of the translucent screen, whereas in the old forms the burners were placed on opposite sides of the illuminated screen. But another essential difference from the older forms of photometer, which provided for one fixed and one travelling source of light, is that in the new photometer both sources of light are fixed in position at accurately measured distances from the observing screen. The equating of the illumination of the screen is brought about by adjusting the supply of the gas which is being tested to the Sugg's London argand-burner. The new photometer and standard lamp have now been in use for some time in the fixed testing-stations and in different buildings in the area of the county of London. The gas-examiners who have constantly employed the new apparatus express a decided preference for it as compared with the bar-photometer; and they have readily adapted themselves to the somewhat special manipulation and observation which it requires

THE phenomenon of "accidental double refraction," which occurs in liquids when these are subject to changes of shape, or, to describe more correctly, rates of strain, forms the subject of an article by Prof. Ladislaus Natanson in the *Bulletin* of the Cracow Academy. The author gives an investigation, mainly hydrodynamical, of the case where the rates of strain are produced in a viscous liquid contained in the space between a rotating cylinder and a concentric cylindrical envelope. A formula is found connecting the angular velocity of the cylinder with the double refraction per unit length, and this formula appears to agree well with some of the experimental results of Umlauf and De Metz.

AN illustrated article on the Kress flying machine appears in *Die Umschau* for June 8. As has been stated in previous accounts in several journals, the apparatus is a multiple winged machine attached to a light boat, and the proposed method of experimenting is to drive the boat through the water until a sufficient speed has been attained for the thrust on the wings to cause it to rise from the surface. The writer of the article, however, evidently considers that the construction of the "air ship" has been somewhat prematurely pushed forward, seeing that the most important part of the apparatus, namely, the motor, is not yet ready. He also is of opinion that the problem of landing has not been sufficiently studied. Several experiments have already been made with the apparatus, without, however, leaving the water; but it will be when the machine has been made capable of lifting itself into mid-air that the chief difficulties of the investigation will arise.

THE fourth annual dinner of old students of the Central Technical College will be held on Wednesday, July 3, with Prof. O. Henrici, F.R.S., in the chair. Tickets can be obtained from the honorary secretary, Mr. Maurice Solomon, 12 Edith Road, West Kensington.

CAPTAIN STANLEY FLOWER sends us his Report, as director, of the Ghizeh Zoological Gardens for the year 1900. The list of donations is a satisfactory one, and we are glad to note that very much has been effected during the year in the way of adding new buildings and improving old ones, as well as in making additional aviaries and enclosures in the gardens.

IN the first part of a new biological journal—the *Bulletin* of the Brooklyn Institute—Mr. A. G. Mayer discusses the variations displayed by a species of Medusa from the Florida seas. The species in question is considered to have been derived very recently from a form common in Florida waters, but to be so distinct as to constitute a genus by itself. "It is remarkably variable, and its great commonness attests to its successfulness in the struggle for existence. In its variations it illustrates the manner in which other newly arisen races of animals may have suddenly given rise to still more diverse species."

PARTS ii. and iii. of the third volume of *Annotationes Zoologicae Japonenses* are devoted to a list of the fishes of Japan, by Messrs. Jordan and Snyder. A total of 686 species are recognised. Apart from its importance to the students of ichthyology, this communication is worthy of the best attention of those interested in the distribution of marine animals, as the authors have been enabled to divide the Japanese marine fish-fauna into four distinct groups. There are the northern or Yezo group, the temperate or Nippon group, the semitropical or Kiusiu group, and the Bassalian or deep sea group. The fish fauna of the Kurile Islands, which is probably very similar to that of Kamchatka, belongs to a distinct subarctic group, while that of Formosa probably pertains to the tropical Malayan assemblage.

THE structure of the hairs of the Patagonian ground-sloth and of the living South American edentates forms the subject of an essay by Dr. W. G. Ridewood, which appears in the May issue of the *Quarterly Journal of Microscopical Science*. The most generally interesting of the author's observations are those relating to the hairs of the two living types of sloth, and the structure which permits of the growth of an alga in each. In the three-toed sloth the hair is invested with a thick extra-cortical layer. "The layer has a tendency to crack in a transverse direction, and in the cracks there come to lodge unicellular algæ, to which Kühn has given the name *Pleurococcus bradypi*. The moisture of the climate in which Bradypus lives enables the alga to live and propagate in this curious position, and the sloth acquires a general green tint which must render it very difficult to distinguish as it hangs among the green foliage." In the two-toed sloth, on the other hand, the bulk of the hair is composed of cortex which is longitudinally fluted or grooved, the grooves being filled with strands of extra-cortex in which flourishes an alga (*Pleurococcus choloepi*) distinct from the one infesting the hairs of the three-toed species. Of quite a different type are the hairs of the ground-sloth, which are smooth and solid, Dr. Ridewood rejecting the idea of Dr. Lönnberg that they were originally coated with a cortex that has now perished. An important biological contribution to the same journal is the life-history of a North American bivalve mollusc, *Nucula delphinodonta*, by Prof. G. A. Drew, of the University of Maine.

UNDER the title of "Zoological Gleanings from the Royal Indian Marine Survey Ship *Investigator*," Major Alcock has collected together the biological observations made by the different medical officers who have served on board during his own connection with the vessel. These observations, the author tells us, are buried in reports that are not readily accessible, or scattered through papers on systematic zoology where they may easily be overlooked. The observations are arranged under eight headings, namely, commensalism; sexual characters, pairing and viviparity; sounds made by marine animals; notes on stalk-eyed crustaceans; instances of protective and warning coloration; phosphorescence; peculiarities in food of marine animals; and notes on reptiles and fishes. The "gleanings" are really a mine of information to the naturalist, and the author has rendered a distinct service to his fellow-workers in producing them in their present form. Among notable instances of commensalism is the case of the hermit-crab protected by a bag of sea-anemones. Another instance has often been observed on the reefs of the Andamans, where a crab of the genus Cryptodromia is protected by a sponge, which is shaped like a cap and tightly fitted to the crustacean.

GEOLOGICAL students and others interested in the science of the earth will find many desirable works in a classified catalogue of books and pamphlets on geology just issued by Messrs. Wesley and Son. The catalogue contains no less than 2225 titles of works in various departments of geological science, classified under 28 headings. It includes the geological library of the late Mr. G. H. Morton, of Liverpool. A glance through the catalogue will repay any geologist anxious to increase his library.

The cryptogams collected by Dr. F. Welwitsch in 1853–1861 are described by the botanists who have determined them in the new volume (vol. ii. part ii.) of the "Catalogue of Welwitsch's African Plants," published by the trustees of the British Museum. Though the plants were collected more than forty years ago, the collection is in some respects the most extensive and representative yet obtained from Africa. The species now described belong to the vascular cryptogams, mosses, hepatics, marine algæ, freshwater algæ, diatomaceæ, lichenes, fungi and mycetozoa.

A MEMORIAL of the late Dr. George Brown Goode, together with a selection of his papers on museums and on the history of science in America, has been published in the form of a volume by the Smithsonian Institution. Dr. Goode was held in the highest regard in all places where natural science is cultivated, and this account of his life and services will be cherished by everyone who is aware of the influence he exerted upon museum development. The addresses delivered at the memorial meeting held at the U.S. National Museum are printed, and also an appreciative notice of his life and services to science, by Prof. S. P. Langley. Eight papers are published in the volume, most of them dealing with museum administration and the pursuit of natural knowledge in America. There is much of interest in these papers concerning the growth of scientific institutions in the United States, and united they form an appropriate memorial of an accomplished man.

AN interesting synthesis of some aromatic aldoximes by means of fulminating silver is described by Messrs. R. Scholl and E. Bertsch in the current number of the *Berichte*. If a polyhydroxylic derivative of benzene is dissolved in ether, some fulminating silver suspended in the solution, and hydrochloric acid led slowly into the well-cooled solution, the silver fulminate disappears and the hydrochloride of the new aldoxime crystallises out. The method has been successfully applied to resorcinol, orcinol, pyrogallol and phloroglucinol.

THE same number of the *Berichte* contains an account by C. Harries of the preparation and properties of the dialdehyde of succinic acid. The aldoxime of this aldehyde can be prepared by the method of Ciamician and Dennstedt from pyrrol and hydroxylamine, and this, suspended in water and treated with nitrous acid, gives an aqueous solution of the new dialdehyde from which the pure substance can be isolated with some difficulty by fractional distillation. Succinic aldehyde is the first member of the aliphatic dialdehydes to be isolated in a pure monomolecular form, and is of interest as being the starting-point for the preparation of the three heterocyclic rings, furane, thiophene and pyrrol. The ready convertibility of this aldehyde into derivatives of these three rings is shown experimentally in the present note.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. W. B. Bingham; an Otter (*Lutra vulgaris*, ♂), British, presented by Mr. W. Radcliffe Saunders; twelve Black Vultures (*Cathartes atratus*) from America, presented by Dr. E. A. Goeldi; two Cambayan Turtle Doves (*Turtur cambayensis*), a White-collared Ouzel (*Merula albicincta*), a Large Andaman Parrakeet (*Palaeornis magnirostris*), a Tickell's Flower-pecker (*Dicaeum erythrorhynchus*), a Cinnamon Tree Sparrow (*Passer cinnamoneus*), a Rufous-breasted Accentor (*Tharrhaleus strophiotus*), a Black-throated Accentor (*Tharrhaleus atrigularis*), an Eastern Meadow Bunting (*Emberiza stracheyi*), four White-capped Buntings (*Emberiza stewarti*), two Indian Button Quails (*Turnix tanki*) from British India, presented by Mr. E. W. Harper; a Northern Mocking-bird (*Mimus polyglottus*) from North America, presented by Mr. H. C. C. Gülich; an Antillean Boa (*Boa diviniloque*) from the West Indies, presented by Mr. D. F. Mackenzie; a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa, a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, a Smooth-headed Capuchin (*Cebus monachus*) from South-east Brazil, two Wanderoo Monkeys (*Macacus silenus*, ♂ ♀), a Banded Parrakeet (*Palaeornis fasciata*), a Ring-necked Parrakeet (*Palaeornis torquata*), two —— Snakes (*Cerberus rhynchops*), thirteen —— Fish (*Saccobranchus fossilis*) from India, a Golden-naped Amazon (*Chrysotis auripalliata*) from Central America, a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, a Shining Parrakeet (*Pyrrhulopsis splendens*) from the Fiji Islands, a Blue-winged Green Bulbul (*Chloropsis hardwicki*) from British India, two Japanese Terrapins (*Clemmys japonica*) from Japan, a Blue Lizard (*Gerrhonotus caeruleus*) from Western North America, deposited; two Chinchillas (*Chinchilla lanigera*) from Chili, purchased; a Llama (*Lama peruana*), a Hybrid Lemur (between *Lemur xanthomystax* and *L. brunneus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF NOVA PERSEI.—In the *Mem. de la Soc. degli Spett. Ital.* (vol. xxx. pp. 77–90), Prof. A. Ricco describes the observations of the brightness and spectrum of Nova Persei, made at the Catania observatory. The various magnitudes given are similar to those already published by other observers, the light curve showing distinct oscillations from March 8.

The spectra were observed with the Merz refractor of 0·33 metre aperture and McClean star spectroscope, and photographs obtained with the photographic equatorial and Vogel spectrograph, the spectra being about 43 millimetres long, with exposures of one hour. The wave-lengths are given as follows:

3933 K	... 4179	... 4541	... 4923
3969 H	... 4235	... 4587	... 5019
4015	... 4310	... 4609	... 5168
4039	... 4341 Hγ	... 4636	... 5300
4071	... 4412	... 4681	... 5551
4102 Hδ	... 4493	... 4862 Hβ	... 5627

COMET 1901 *a*.—The comet is now getting so far away from the sun that it is in all probability beyond the reach of any but the largest instruments. The following ephemeris may be of service to those having sufficient optical power:—

Ephemeris for 12h. Berlin Mean Time.

1901.	R.A. h. m. s.		Decl. ° ′
June 21	7 24 56	...	+10 8·3
23	28 6	...	10 16·1
25	31 9	...	10 23·1
27	34 7	...	10 29·5
29	7 37 0	...	+10 35·2

NEW VARIABLE STARS:—

74, 1901 (Persei). Herr P. Guthnick, of Bonn, finds that the star

$$\left.\begin{array}{l}\text{R.A.} = \ \ 3^{h}\ 2^{m}{\cdot}7\\ \text{Decl.} = +44^{\circ}\ 29'\end{array}\right\}(1900)$$

is variable to the extent of 0·6 magnitude. From the table of magnitudes given the period would appear to be about thirty days, but the gaps are too long for any accurate estimate. This star is the intensely orange-coloured χ Persei.

75, 1901 (Persei). Herr Fr. Deichmuller, of Bonn, finds variability in the star 36 Flamsteed, amounting to about 0·5 magnitude. The observations indicate a change from 4·92 to 5·65 magnitude twice a month. The variability of this star is confirmed by Herr Guthnick (*Astronomische Nachrichten*, Bd. 155, No. 3720).

FORMS OF IMAGES IN STELLAR PHOTOGRAPHY.—In the *Annals* of Harvard College Observatory (vol. xli. No. vi. pp. 153–187), Mr. E. S. King, the observer in charge of the photographic department at that institution, describes the various disturbing causes which affect the forms of star images obtained by photographic methods with different systems of following. The chief of these are irregularities of the driving clock, differential refraction, and flexure. To correct these errors two methods of guiding have been employed, the plate being moved by suitable adjusting screws, either with the telescope or independently of it, the latter method being preferred, as it permits, not only corrections in two coordinates perpendicular to each other, but also a rotary movement for the elimination of flexure and differential refraction.

The investigations described have been in hand since 1896, when they were undertaken in consequence of difficulties occurring in the observation of the Algol variable W Delphini at low altitudes. A fourth source of error, in the adjustment of the polar axis, must be also considered, and it is practically important to do this, inasmuch that by an accurate knowledge of the conditions it is possible to introduce such an amount of error from this and the clock rate as to partially eliminate the variable errors due to flexure, &c. After insisting on the necessity of the clock having as continuous and regular motion as possible, it is pointed out that the correct rate for following is not sidereal time, as is commonly supposed, but a variation from this depending on the latitude and the declination of the object. The equations of condition are developed for determining the proper following rates for various localities. The actual path of a star on the plate as affected by refraction may be either a parabola, hyperbola, ellipse or circle. The effect of error of the polar axis is an elliptical form of star image, varying with the declination. The analytical investigation of this shows that the refraction in declination can to a great extent be eliminated by an alteration of the inclination of the axis; this is now provided for in many instruments by the frequent shifting of the polar axis by known amounts. The correction for the right ascension component is more complicated, and tables are given showing the changes per hour for various hour angles. Reproductions from photographs taken with clock rate adjusted for refraction and polar axis elevated are shown. In considering the effects of flexure three kinds are discussed, affecting either the polar or declination axes, and the tube. Various methods actually in use at the Observatory for determining the flexure are then described in detail, also the exact method of varying the load of the control pendulum governing the driving clock. The effects of temperature on the trails have also been considered, and methods for its elimination.

As the result of the investigation, it is found that plates of 60 minutes' exposure may be taken without visual following, which shall have images not exceeding 0·01 cm. in elongation due to the clock, and a photograph of the cluster in Hercules taken in this way is reproduced. Several special applications of these principles are then discussed, including the important one of photographing stellar spectra with the objective prism, where the spectrum lines are often very oblique, thus lessening the dispersion and possibly the definition. A table is calculated showing that this may be corrected by a slight rotation of the prism for each star.

Several methods for the mechanical correction of flexure are indicated, and finally the special means for correcting proper motions of the object under examination are considered, examples of the photographs of Eros being given in illustration.

THE SIXTH ANNUAL CONGRESS OF THE SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES.

THIS Congress was held at Haslemere and Hindhead on June 6-8, and delegates and members representative of most of the affiliated societies upon the Union's list were in attendance. There were, further, a goodly number of visitors present, attracted to a large extent by the unbounded hospitality of the residents and admirable arrangements of the local committee, which were most elaborate and highly successful.

The proceedings were opened by Prof. G. B. Howes, F.R.S., who, as the retiring president, in a few apposite remarks resigned the chair to his successor, Mr. G. A. Boulenger, F.R.S., who then delivered the annual address. Taking for his subject the field-work and results of experiment of the past quarter of a century upon the European Reptilia and Batrachia, he led up to the formulation of a revised list of the British species. He then dealt in greater detail with those genera and species inhabiting the immediate neighbourhood of the meeting, special interest attaching to some facts involving the natterjack and Gilbert White's area of observation, in their relation to the topic of batrachian migration; and he seized the opportunity to enlist the services of local naturalists in the study of this problem, in the better working-out of the varieties of the common viper, and in other allied herpetological matters for which the study of the local fauna presents a favourable opportunity. Beyond this the address, which was admirably suited to the occasion, contained historical records of permanent value and some wholesome advice to the collector and would-be specialist, based upon the author's great experience of herpetological affairs.

The meetings for strictly scientific business were confined to the Friday and Saturday mornings, five papers being read. An unusual departure, however, was entered upon, in the substitution of three short addresses for the musical entertainment customary on similar occasions at the evening *soirée*. The reception at this was by Sir F. Pollock, Bart., and in his capacity as president of the local natural history society he delighted those present with a felicitous speech. The short addresses which followed this were by Mr. G. F. Chambers, on "An Eclipse Trip to Portugal in 1900"; by Mr. Oswald Latter, of the Charterhouse, on "Cuckoos' Eggs"; and by Dr. Jonathan Hutchinson, F.R.S., on "Habit and Discipline in their Influence on Organisation." The latter, on the lines of the famous Sunday afternoon discourses with which the indefatigable doctor is in the habit of improving the minds of his friends and visitors, both at Haslemere and in London, was noteworthy for the attempt to prove that the orbital bulla of the hippopotamus, shown to be different in origin in each of its two stages of development, is, like that of the gavial, functional as a support for the eye during protraction and elevation; and for the thesis that in human affairs the poet must precede the philosopher.

Dr. Hutchinson further contributed to the educational success of the meeting by entertaining the assembled guests at his private museum at College Hill, the originality of the plan of arrangement of which was much admired; and, with characteristic versatility, he followed this up by leading the way to Lord Tennyson's abode at Blackdown, before which, after a visit to its interior, verses appropriate to the occasion were by him and others recited.

Of the papers read at the ordinary meetings, the first, by the Hon. Rollo Russell, on "Moisture in the Atmosphere," is the embodiment of a lengthy series of experimental and statistical observations which will be of much service for reference. This was followed by a paper by Miss E. Sargent on "Seedlings," chiefly noteworthy for some observations made in conjunction with "a colleague," in which a downward displacement of the seed by forcible contraction of the roots was fully described and illustrated by an ingenious model. Prof. Howes concluded the first morning's work with a short lecture, which he said was pertinent to his presidential address of the previous year. He dealt with the principle of "convergence," as applying more especially to recent work among the Mammalia and Batrachia ecaudata, and with "substitution" in its bearings on the study of the electrical organs of fishes.

The afternoon of Friday was given to the reading of a couple of papers on "The Teaching of Nature Knowledge in Elementary Schools," by Miss M. A. Buckton, who has had considerable experience of elementary school-work both on the Continent and at home, and by Prof. A. D. Hall, principal of the Wye Agricultural College. Upon these a discussion arose, which, for lack of organisation beforehand and time for extension, fell short of what might have been an important issue.

The concluding paper of the meeting was by Mr. S. T. Dunn, secretary to the Director of Kew Gardens, under title "The Origin of Certain Weeds." The author read an account of the geographical distribution of certain dead nettles, and in the short discussion which ensued doubt was expressed whether he had pointed to anything which does not apply to certain other British plants well known, while there arose a difference of opinion which left the audience in uncertainty as to what constitutes a "weed."

At the meeting of delegates, which closed the proceedings, the question of subscription was discussed; and conspicuous among the motions passed was one of appeal to the Brighton Town Council, who are about to take the famous Aquarium of that town in hand for development, to make adequate provision for scientific investigation and work in economics, in a manner which was agreed upon.

The exquisite country in which the meeting was held and the delightful weather which prevailed proved both beneficial and attractive, and not the least pleasurable feature of the Congress was the manner in which the influential residents, both by their generous hospitality and personal interest, contributed to its success, while the vociferous croaking of some introduced frogs came as a most appropriate accompaniment to the proceedings.

The Congress for 1902 is to be held at Canterbury, under the presidency of Dr. Jonathan Hutchinson, F.R.S., who has served the recent one so well.

SOME RECENT WORK ON DIFFUSION.[1]

II.

WE have seen that when steady diffusion is going on down a cylindrical column which is absorbent at the bottom there is a uniform diminution in the density of the diffusing substance from one end of the column to the other, evidenced in the case of a coloured substance by a gradual and uniform thinning out of the colour in the direction of the axis of the column. But in any horizontal cross-section of the column the colour is of the same intensity in all parts of the section, which means, of course, that the diffusing substance is of equal density along these planes.

In a diagrammatic section of such a column we should therefore represent the surfaces of equal density by straight lines drawn at right angles to the axis of the cylinder, and the stream lines of the diffusing substance by straight lines drawn parallel to the axis.

I am able to show you the horizontal lines of equal density in a cylinder, produced by a process of intermittent diffusion presently to be described.

When diffusion goes on into a flat absorbent disc, or aperture, instead of into a cylinder, it is clear that the stream lines of the diffusing substance must strongly converge towards the disc instead of moving vertically downwards as they do in the cylinder, and it is also clear that the lines or surfaces of equal density in the diffusing substance must form curved surfaces of some kind over the disc. We must now consider the exact form which these lines and surfaces will take.

It so happens that there is a problem in electrostatics which is analogous to the one before us, and it is one which has been fully worked out by mathematical physicists.

When an insulated conductor receives an electric charge the form taken by the surfaces of equi-potential around the conductor

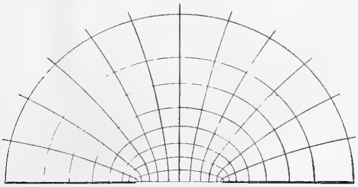


FIG 1.

depends on its shape, and on the nature and distribution of other charges in its neighbourhood.

If we suppose the absorbing disc or perforation used in our diffusion experiments to be replaced by an electrified disc of similar dimensions, embedded flush in a wide non-conducting rim, then the surfaces of equal electric potential in the air above the disc will take the form represented in Fig. 1. The surfaces will form a series of hemi-spheroids which in any vertical section passing through the centre of the disc will give a series of ellipses, having their common foci in the edges of the disc. Faraday's lines or tubes of force, on the other hand, will in this case be represented by a series of hyperbolas, also having their foci in the edges of the disc.

Now we have every reason to believe that in a diffusion experiment with an absorbent disc the surfaces of equal density of the diffusing substance over that disc are the exact analogues of the surfaces of equi-potential over the similar electrified disc, and that the stream lines of the diffusing substance are the analogues of the lines or tubes of force. If this is so the diagram will equally well represent an experiment in which, for instance, the carbonic acid of perfectly still air is being absorbed by a disc of soda solution, surrounded by a wide rim.

Fig. 2 represents what we might expect to be the state of things when diffusion takes place through a circular aperture in a diaphragm. Here the stream lines of the substance, which are convergent as they approach the aperture, diverge again when the opening is past, and we should expect to get a double system of the ellipsoidal zones of equal density on either side of the aperture.

Did time permit I could show you that this hypothesis is not only capable of giving reasonable and consistent explanations of all the phenomena of diffusion into and through apertures, but completely explains the "diameter law," and also enables us to predict the amount of gas, vapour, or solute which will pass under given conditions, and the results can be verified by experiment.

I have only time to glance at one or two readily verifiable deductions from this hypothesis. In the first place, it fully accounts for what I have called the "diameter law," that is to say, that diffusion through circular apertures in a diaphragm is proportional to their diameters, not to their areas.

In two diagrams on the wall we have represented the arrangement of the equi-density curves and stream lines over two absorbent discs, one double the diameter of the other. We may take these discs to represent an alkaline solution absorbing carbonic acid from the air.

The two systems are on the same relative scale, but one is magnified by two diameters.

It will be seen that a curved line corresponding to any given actual density of the diffusing substance must be twice as far from the surface of the larger disc as it is from the surface of the smaller; that is to say, the *gradient of density* on which the flow depends is twice as steep over the small disc as it is over the large one. From this it follows that for equal areas the flow into the smaller disc is twice that into the larger and that the *total* flow must be proportional to the diameters, which is just what is found to be the case

Wherever we get conditions favourable for the formation of a

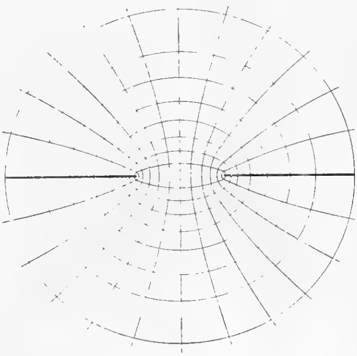


FIG. 2.

system of equi-density zones on one or both sides of a perforated diaphragm, diffusion will go on in accordance with this "diameter law." But one system of zones is quite sufficient for the purpose, so that in a case like that of Fig. 2, which represents the course of diffusion of atmospheric CO_2 in perfectly still air into an absorbent chamber, we might allow the outer system of equi-density shells over the aperture to be completely swept away by air currents, and still the "diameter law" would hold good on account of the inner series of zones, which, from their position, are protected from the air currents. This explains in a very satisfactory manner why it is much more easy to demonstrate the diameter law with apertures in a diaphragm than simply with absorbing discs, where only one external system of equi-density shells can exist, which is, of course, extremely liable to be influenced by disturbing currents.

Satisfactory, however, as this hypothesis is in explaining everything connected with these curious facts of diffusion, it must be borne in mind that the reasoning on which it is based is in part deductive and in part dependent on an analogy.

Nearly 300 years ago it was said by Sir Thomas Roe that "many things hold well in discourse, and in the theorique, satisfie curious imaginations, but in practice and execution are found difficult and ayrie."

Fortunately this does not apply to the present case, and I am able to bring before you this evening for the first time an experimental demonstration of the existence of zones of equal density in the neighbourhood of an aperture through which diffusion is

[1] Discourse delivered at the Royal Institution, Friday, March 22, by Dr. Horace T. Brown, F.R.S. (Continued from p. 174.)

going on, and to show you that they have the exact shape which the theory requires.

I have here a rectangular glass cell divided horizontally by a thin plate of celluloid having a circular hole punched through it. The lower half of the cell is filled with a solution of gelatine containing a little barium chloride, and the upper half with a solution of sodium sulphate.

The relative strengths of the solutions are so adjusted that the two salts, diffusing in opposite directions, shall meet somewhere in the gelatine where a precipitate of barium sulphate is thrown down at the surfaces of contact of the two opposing streams of diffusion. The result is that we get a slowly growing, spheroidal mass of precipitate, starting from the aperture and resembling in shape the head of an inverted mushroom.

If we arrange for the diffusion of the sodium sulphate to be intermittent, or, better still, if we alternate the diffusion of a sulphate with that of a chromate, we get well-marked *zonings* in the precipitate forming the spheroid, zonings which correspond to the successive forms which the spheroid has assumed during growth, and which, therefore, must have been zones of equal density of the diffusing substances. We can study the forms which these assume in relation to the aperture by subsequently cutting sections through the gelatine, but by a little arrangement we can make the apparatus cut its own sections as the diffusion goes on.

This is done by making the aperture in the diaphragm *semi-*

FIG. 3.

circular instead of circular, and bringing its straight edge close up to the side of the glass vessel.

I will now throw on the screen some photographs of vertical sections of spheroids of diffusion of this kind. (See Fig. 3 and Fig. 4).

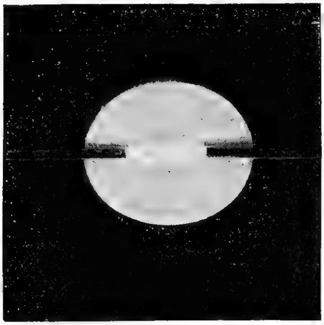


FIG. 4.

On comparing the lines of equal density around the aperture with the diagrams on the wall you will at once see that their shape is exactly that required by theory—they describe a series of ellipses having their common foci in the edges of the aperture through which the diffusion is taking place.

The actual stream lines of the diffusing substance are not visible, but as these must necessarily be normal to the curves of equal density they can only be represented by a series of hyperbolas, also having their foci in the edges of the aperture.

The electrostatic analogy which has served us so well in determining the form of the zones of equal density around *single* apertures may also be used for predicting their distribution around a series of apertures in a diaphragm.

If we regard the individual holes in a multiperforate diaphragm as so many minute discs, all electrified to a common potential, the lines of equi-potential and the lines of force should take a form something like that represented in the diagram, Fig. 5, the lines of equi-potential forming complete ellipses in the immediate neighbourhood of the electrified discs, but gradually intersecting and forming a series of wavy lines, which become more and more horizontal as the distance gets more remote.

Could they be rendered visible these are also the forms which we should expect the lines of equal density of a substance to take when it is diffusing through a series of small apertures. I am

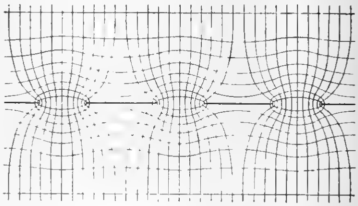


FIG. 5.

able to give you a verification of this by throwing on the screen photographs showing the result of intermittent diffusion through a series of such apertures (Figs. 6 and 7). The lines of equal density are marked out by the alternate bands of sulphate and chromate of barium as they were in the last experiment.

From the shape of these lines of equal density it is possible to determine the form of the stream lines of the diffusing substance and to show that the tendency of a multi-perforate septum of this kind is to locally increase the gradient of density in its neighbourhood and so to accelerate the flow through the small apertures. We get, in fact, a complete and satisfactory explanation of the small amount of obstruction which such a diaphragm produces when put in the way of a diffusive flow of gas or liquid.

Intermittent diffusion such as I have described may be used to illustrate in a variety of ways the distribution of electric potential around electrified bodies which are within the sphere of each other's action.

It is generally a difficult and laborious task to work out the distribution of the surfaces of equi-potential around electrified bodies which are near enough to influence each other. By this system of intermittent diffusion we may sometimes make Nature

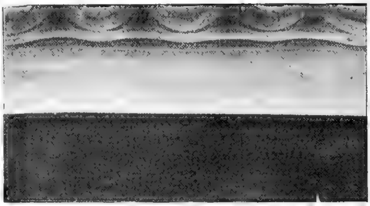


FIG. 6.

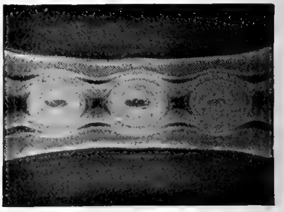


FIG. 7.

work out the problem for us. Here, for instance (see Fig. 8), is a figure copied from Clark Maxwell's "Electricity and Magnetism," representing the form which is assumed by equi-potential surfaces around two points charged with quantities of electricity of the same kind in the ratio of 4 to 1. If the analogy is correct diffusion, through apertures having their diameters in the ratio of 2 to 1 ought to give the same series of figures. You see from the photograph of an actual experiment given in Fig. 9 that this supposition is correct.

In Fig. 10 are given the calculated lines of force at the edges of two parallel plates, one of which is insulated and electrified, the other connected with the earth. These ought to correspond in shape to the equi-density lines of a substance undergoing steady diffusion from between two parallel plates, as, in fact, you see they do. (See Fig. 11).

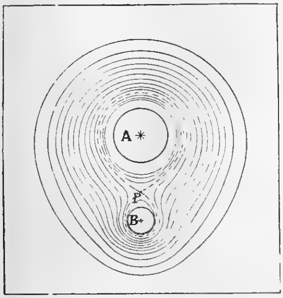


FIG. 8.

But considerations of this kind, although of interest in showing the striking analogies between certain phenomena of electrostatics and static diffusion, would carry me too far from my main subject, and I must again bring you back to the green leaf which was the starting point of my lecture.

If we regard the structure of the leaf from the new point of view which now suggests itself we can readily understand how it is that the stomates, notwithstanding the relatively small area of the leaf surface which they occupy, can drink in the atmospheric carbonic acid with such rapidity.

The finely perforated epidermis of the leaf, tightly stretched over the interior air-spaces, whose walls can absorb carbonic acid, constitutes a multiperforate septum which is under the most favourable conditions to produce an acceleration of the diffusive flow of the gas into the leaf.

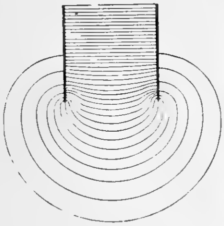


FIG. 10.

The laws of gaseous diffusion through small apertures are now so well understood that we can predict with certainty the particular quantitative effect produced on a given diffusive flow by any screen with perforations of known size and distribution providing they are not within a certain number of diameters distant from each other. These deductions can then be verified by experimenting with small shallow glass cylinders, made absorbent inside, and closed at the top with very thin discs of celluloid perforated in a known manner. Such a piece of apparatus may be regarded as an artificial leaf, the perforated celluloid representing the epidermis with its stomates, whilst the absorbing solution of caustic soda acts the part of the assimilating centres.

Having obtained confidence in the accuracy of the method of calculation we can then apply the same principles to determining the efficiency of the leaf stomates, when the whole system is regarded as a piece of mechanism for promoting diffusion.

In the first place it is found experimentally that the most economical arrangement of very small apertures is to have them set about 8 or 10 diameters apart, for at that distance the interference with each other practically ceases. *This is about the distance at which we generally find the stomates arranged on the underside of most leaves.*

You will remember that the amount of atmospheric carbonic acid which enters an assimilating leaf in an hour is about ·1 c.c. for every square centimetre of leaf. Now it can be shown that for this amount of gas to enter through the stomates it is only necessary for the CO_2 content of the air just within the leaf to be kept down to 2·8 parts per 10,000, when that of the outer air is 3 parts per 10,000. This very slight difference in the partial pressure within and without is quite sufficient to account for all the entering CO_2, thanks to the special structure of the leaf.

Thus all the apparent difficulties in the way of accepting the

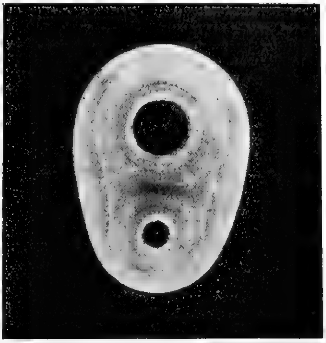


FIG. 9.

minute stomates as the sole pathways of gaseous exchange in the leaf entirely disappear when the leaf is studied in this new light, and it becomes evident that the adjustment of the mechanism of the leaf to the physical properties of its surrounding medium is far more perfect than has been hitherto suspected. The leaves of plants have, in fact, proved to be better physicists

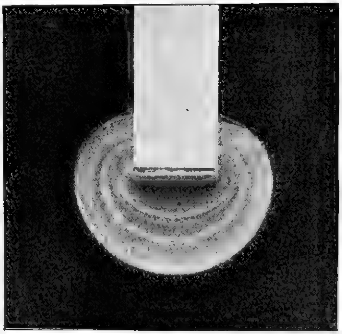


FIG. 11.

than we are, since their structure bears the impress of response to certain properties of gases of which we have hitherto been ignorant.

This is by no means the first occasion on which the plant has given us a lead in physics. The theory of dilute solutions, formulated by van 't Hoff, and indicating that the laws of Boyle and of Avogadro are as applicable to dilute solutions as they are to gases, had its origin in the observations of De Vries and of Pfeffer on the plasmolysis of living cells and the properties of natural semi-permeable membranes.

Nor can we doubt that there are many more such instances which only await detection, and we may reasonably hope that the boundaries of physics and of chemistry will be materially enlarged in unexpected directions if we pay due regard to the whispered hints and slender clues which are on all sides given by the living world of Nature.

A LONG PERIOD SUNSPOT VARIATION.[1]

IT has long been known, and Dr. Rudolf Wolf of Zurich was the first to draw attention to it, that the length of a sunspot period is only in the *mean* eleven years, and that the real length of any one period might differ from this value by as much as ± two years. Another fact of observation is that the times of maxima do not occur a constant number of years after a preceding minimum, and Dr. Wolf determined the *mean* interval as 4·5 years. The minimum also follows the maximum in a *mean* interval of 6·5 years.

It has further been noticed that the intensity of each period, *i.e.* the total amount of spotted area included between one minim um and the next, was not constant. Dr. Wolf held that

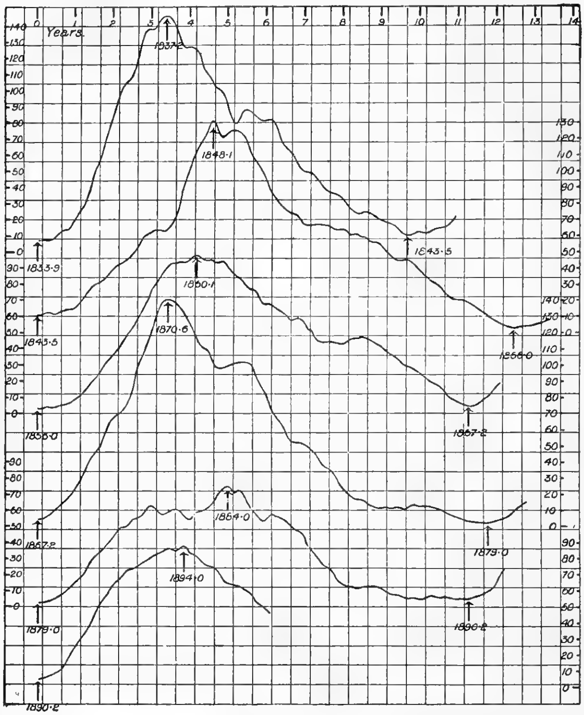


FIG. 1.

these quantities indicated a certain periodicity, and at first suggested a period of 178 years, and later 55·5 years, or a period extending over five eleven-year periods ($11·1 \times 5 = 55·5$).

The present investigation was limited to the interval of time, namely, 1833–1900, over which *systematic* observations of the sun's surface have been regularly made, and as Dr. Wolf's relative numbers agree well with the actual facts of observation over this period, these numbers have been employed.

The important magnetic results obtained by Mr. William Ellis served as a check on the whole work, since he has shown that the curves for the magnetic elements are in almost exact accord with those of the sunspots. Any variations determined from the sunspot curves should, then, have their counterpart in the magnetic curves.

Fig. 1 will give the reader an idea of each sunspot curve from minimum to minimum for the period above mentioned.

They are so arranged in order of date that each individual curve can be examined separately. The times of succeeding minima are arranged vertically under each other, so that any variation as regards acceleration or retardation of the following maxima, and any inequality in the length of the period minimum to minimum can be seen at a glance; each of these epochs is indicated in the figure by a short arrow with the corresponding dates.

Dealing with the inequalities of the interval minimum to maximum, it is found that there is a regular variation having a period of about thirty-five years. Curve B, Fig. 2, shows this variation, the abscissæ representing the time element and the ordinates the intervals minimum to maximum plotted at the epochs of the minima.

Dealing with the intervals minimum to maximum of the magnetic curves in a similar way, the result obtained is shown in the same figure, curve C.

Both these curves thus indicate that there is some law at work which introduces a secular variation by retarding periodically the sunspot maxima in relation to the preceding minima. The actual epoch of maximum relative to the preceding minimum oscillates about the mean value 4·12 years, its greatest amplitude being in the mean about 0·8 year.

Another point of great importance is that when the epoch of maximum spotted area follows in the shortest interval of time after a minimum, the spotted area for the whole period is greater than at any other time.

Thus, if the spotted area included between consecutive minima be summed up for each period, and these values, used as ordinates, be plotted at the epochs of minima, as done previously, and the curve inverted, curve D Fig. 2 is the result. It will be noticed that this curve is very similar to the two immediately above it, and shows a period of about the same length, namely, about thirty-five years. It may be here remarked that the value for the total spotted area for the period 1833·9 to 1843·5, the earliest value in point of time dealt with, is not quite in harmony with the other values. There seems, however, sufficient evidence to indicate that the small value may be due to the fact that the observations were not then made quite on a uniform plan. That the maximum of 1836 was a great one, and only equalled by that of 1870, is well known.

The discussion of these observations thus leads to the important conclusion that *underlying the ordinary sunspot period of about eleven years there is another cycle of greater length, namely, about thirty-five years.*

This cycle not only alters the time of occurrence of the maxima in relation to the preceding minima, but causes changes in the total spotted area of the sun from one eleven-year period to another.

A glance at Fig. 1 will show that the length of the period minimum to minimum seems to alternate, the magnitude of these alternations becoming smaller. An attempt was made to see if any law could be traced, but although there was a variation suspected in the length of both the magnetic and sunspot periods (reckoning from minimum to minimum), which increases and decreases in *alternate* eleven-year periods from a mean value, the observations do not extend over a sufficient interval of time to allow a more definite conclusion to be drawn.

It is generally conceded that the spots on the surface of the sun are the result of greater activity in the circulation in the solar atmosphere, and therefore indicate greater heat and, therefore, light. This being so, the curve representing the spotted area may be regarded as a light curve of the sun.

[1] Abstract of a paper, "The Solar Activity 1833–1900," read before the Royal Society on May 23, by Dr. William J. S. Lockyer.

The sun may thus be considered a variable star (1) the light of which (reckoning from minimum to minimum) is variable, with a mean value of about 11·1 years; (2) the epoch of maximum does not occur a constant number of years after the preceding minimum, but varies regularly, the cycle of variations covering about thirty-five years.

It is interesting, therefore, to know that the sun is not the only star which exhibits variations similar in kind to those mentioned above, for the light curve of η Aquilæ not only has a more rapid rise to maximum and slow fall to minimum, but the periods from minimum to minimum vary in length, and the interval minimum to maximum has a regular variation.

Since then, in addition to the well-known eleven-year period of sunspot frequency, there is another cycle which extends over about thirty-five years, and which is indicated clearly, as has been shown, both by the changes in the times of the occurrence of the epochs of maxima and in the variations in area included in consecutive eleven-year periods of both sunspot and magnetic curves, it is only natural to suppose that this long-period variation is the effect of a cycle of disturbances in the sun's atmosphere itself.

Such a cycle, if of sufficient intensity, should cause a variation from the normal circulation of the earth's atmosphere, and should be indicated in all meteorological and like phenomena.

We are indebted to Prof. Ed. Brückner for the great work on the changes in climates, and in this investigation he sought variations in the observations of the height of the waters in inland seas, lakes and rivers; in the observations of rainfall, pressure and temperature; in the movements of glaciers; in the frequency of cold winters; growth of vines, &c.

The result of the whole of the investigation led him to the conclusion that there is a *periodical variation in the climates over the whole earth, the mean length of this period being* 34·8 ± 0·7 *years*.

Prof. Brückner was so convinced of the undoubted climate variations which he deduced, and so certain that such variations could only be caused by an external influence, that he investigated Wolf's sunspot numbers to see whether such a cycle was indicated. Not finding any he was led to make the bold suggestion that such a variation as he sought must really exist in the sun, but might possibly be independent of sunspots. He finally concluded that the climate variations are the first symptom of a long period variation in the sun, which probably will be discovered later.

In the light of the secular period of solar activity dealt with in this article, Prof. Brückner's conclusions are of great interest, because not only does the length of the period, but the critical epochs of his cycle completely harmonise with those found in the present discussion of the sunspot and magnetic curves.

To illustrate more fully this connection and to take only one case, namely, rainfall, three rainfall curves which have been copied from his book are reproduced in Fig. 2 (curves E, F, G).

E and F represent the secular variations for what Prof. Brückner calls "Reguläre Gebiete I and II," while curve E is the mean for the whole set of observations he has employed, and represents the secular variation of rainfall over the whole earth so far as can be determined.

The comparison of these curves with those representing the sunspot and magnetic results given above them shows that when the epoch of maximum spotted area (curve B) follows late after the preceding epoch of minimum (1843, 1878), or when the spotted area from minimum to minimum is least (curve D), the long period rainfall curve is at its maximum or we have a wet cycle. When, on the other hand, the maximum (curve B) follows soon after the preceding minimum (1867), and the spotted area for this cycle is at a maximum (curve D), the rainfall curve is at a minimum or a dry cycle is in progress.

Prof. Ed. Richter, in a detailed investigation of the movement of glaciers, has also found a cycle of thirty-five years, and he pointed out that the variations agreed generally with Brückner's climate variations, the glacier movement being accelerated during the wet and cool periods.

Again, Mr. Charles Egeson not only finds a secular period of about thirty-three to thirty-four years in the occurrence of rainfall, thunderstorms and westerly winds in the month of April for Sydney, but the epochs of maxima of the two latter harmonise with the epochs of the thirty-five yearly period deduced for sunspots.

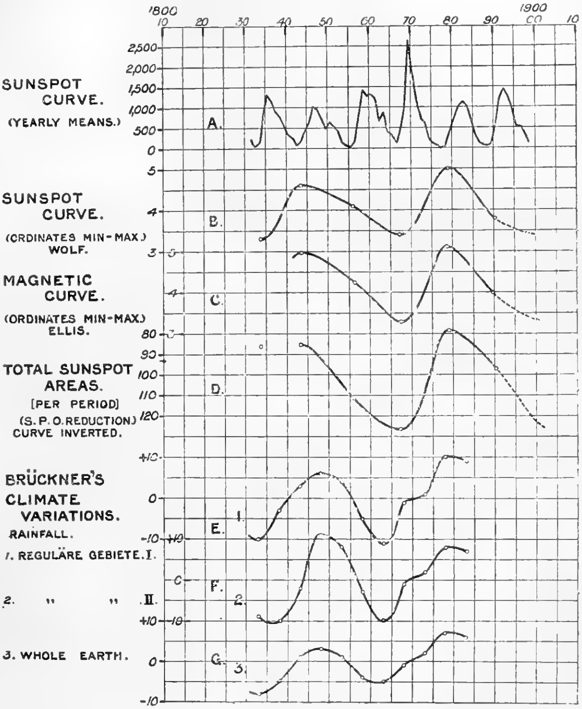


FIG. 2.

There seems little doubt that, during the interval of time covered by the present sunspot discussion, the meteorological phenomena, number of auroræ, and magnetic storms show secular variations of a period of about thirty-five years, the epochs of which harmonise with those of the secular variations of sunspots. As we are now beginning to approach another maximum of sunspots which should correspond both in intensity and in time of occurrence after the epoch of the present minimum with that of 1870·8, it will be interesting to observe whether all the solar, meteorological and magnetical phenomena of that period will be repeated.

WILLIAM J. S. LOCKYER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—At a convocation on June 18, the honorary degree of D.C.L. was conferred upon Mr. Cornelius N. Dalton, C.B., master of the Drapers' Company.

On the same day, the new Radcliffe Library building, which has been erected by the Drapers' Company at a cost of about 21,000*l.*, was formally handed over to the University in the presence of a large number of members of the Company and of the University.

CAMBRIDGE.—Prof. Newton, F.R.S., has been appointed a manager of the Balfour fund for the ensuing five years.

The Harkness scholarship in geology has been awarded to W. G. Fearnsides, Sidney, and the Wiltshire prize in palæontology to E. R. Watson, Jesus.

Thirty-seven names appear in the first class of the natural sciences tripos, part i., and ten in the first class of part ii. Four are the names of Newnham students.

The work of Mr. Hugh Ramage, advanced student of St. John's, on spectrum analysis, has been pronounced "of distinction" as a record of original research and as a qualification for the B.A. degree.

MR. CHAMBERLAIN has addressed a letter to the Lord Mayor of Birmingham, on behalf of the council of the Birmingham University, suggesting that a rate should be made in aid of the University. The amount subscribed for the establishment of the University is 400,000*l.*, but a large proportion of this will be absorbed in the erection and equipment of buildings necessary for instruction and research. The increased cost of maintenance involved in the scheme cannot be wholly provided from the fees of students, and it is on this account that an appeal is made for assistance. In support of the appeal the council refer to the precedents already established in similar cases, notably in connection with University colleges founded in other provincial towns. Thus the corporation of Nottingham contributes 7380*l.* a year to Nottingham College, Sheffield gives nearly 6000*l.* a year to the Firth College, the corporation of Leeds 1500*l.* a year, the corporation of Manchester 1100*l.*, and the corporation of Liverpool, besides a grant of land of the value of 30,000*l.*, an annual contribution of 1800*l.* Other contributions of a substantial character have been made in many cases by the county authorities; and it is hoped that if Birmingham will set the example the counties which will derive benefit from the extension now proposed of University work in the Midlands will not be unwilling to take their share of responsibility. A rate of ½d. in the pound would in Birmingham provide an annual contribution of about 5000*l.*, which would justify the council of the University in proceeding immediately with the new departments, the necessity for which, in view of the increasing pressure of foreign competition, is daily becoming more urgent.

AT the meeting of the General Medical Council last week a prolonged discussion occurred upon the regulations for the first year of medical study, and the educational institutions which should be accepted as fit and proper places for passing one year of the obligatory five years of professional study. The main question was whether a year at a grammar school, or similar educational establishment where general subjects as well as science is taught, should count as one year of medical training in the five years' curriculum. For one side it was stated that the laboratories at some of the institutions recognised by the Council were as well equipped as those of some medical schools. It was also urged that chemistry, physics and biology might be considered as an extension of the preliminary education required before medical study, properly so called, can be commenced, and that the medical curriculum required should be four years taken subsequently to passing an examination in them. If this view is accepted at the next meeting of the Council, it would seem, says the *British Medical Journal*, that the whole question of the places at which instruction may be obtained may disappear, for it will be argued that, provided the necessary knowledge is obtained and tested by adequate examination, it will no longer be the business of the Council to concern itself how or where it is obtained, any more than in the case of Latin or any other subject of preliminary education. The subject has been referred to the Education Committee of the Council, and judging from the views expressed during the debate it seems that there are not a few members who think that scientific education is now provided for so well at schools not strictly medical that one year of professional study may properly be carried out in such institutions.

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, May.—The three papers in the present number were all read at the February meeting of the Society. Non-oscillatory linear differential equations of the second order, by Prof. Bôcher, has for its object the deduction of certain conditions that the equation

$$\frac{d^2y}{dx^2} + \frac{pdy}{dx} + qy = 0$$

should be non-oscillatory. This equation is said to be oscillatory or non-oscillatory in the interval $a \leqq x \leqq b$, according as it does or does not have at least one solution (not identically zero) which vanishes more than once in this interval. Conditions have been obtained by Picard, but the method used in the present paper is not only entirely different, but yields, in addition, other results not given by Picard's method. In the author's opinion it is also less artificial.—Concerning real and complex continuous groups, by Prof. L. E. Dickson, is an attempt to illustrate certain differences and analogies between related real and complex continuous groups. Lie's theory has been developed chiefly for the latter groups, the modifications necessary for real groups being treated quite briefly.—On holomorphisms and primitive roots, by Dr. G. A. Miller, is devoted to some additional developments along the earlier line adopted by the author in a previous paper (*Bulletin*, vol. vi. p. 337, 1900).—The following works are reviewed, viz.: "Einleitung in die Theorie der Besselschen Funktionen" (Prof. J. H. Graf and Dr. E. Gubler), by Dr. V. Snyder; and "Leçons sur la théorie des Formes et la Géométrie analytique supérieure" (H. Andoyer), by H. S. White.—The usual points of interest, collegiate and other announcements, and list of recent publications are well to the front.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 23.—"On the Presence of a Glycolytic Enzyme in Muscle." By Sir Lauder Brunton, F.R.S., and Herbert Rhodes.

For some time physiologists have suspected the presence of some enzyme in muscle which has the power of breaking up the sugar with which the muscle is supplied through the blood, and converting this food into energy with the formation of simpler oxidised bodies. The presence of such an enzyme in fresh muscle juice was apparently proved by Brunton in 1873, but the method of experiment used was open to criticism.

Previous to the present paper the materials used had not been rendered free from possible fermentative organisms, so that it could not be definitely said that the marked glycolytic action exhibited by the juice was not due to some fermenting fungus or bacterial contamination.

The muscle juice was obtained from the yet living flesh of a sheep by comminution with sand and hydraulic expression.

In these later experiments the muscle juice was rendered sterile by filtration through a Pasteur Chamberland candle, the other fluids boiled for considerable periods, and the apparatus disinfected by steam.

Two flasks were prepared, each containing fresh sterile muscle juice and sugar solution; in one the juice was boiled previously to adding the sugar solution.

After incubation at body temperature the sugar in each flask was estimated quantitatively, the result showing a very marked diminution in the percentage of sugar in the flask containing unboiled juice.

Thus it was shown that a substance exists in fresh muscle which has the power of breaking up the sugar molecule, and this substance partakes of the nature of a glycolytic enzyme.

Although an attempt had been made to isolate the enzyme, it is of such a delicate nature that the isolating procedure adopted destroyed its fermenting power.

Physical Society, June 14.—Prof. S. P. Thompson, F.R.S., president, in the chair.—A paper on Herr Jahn's measurements of the electromotive force of concentration cells was read by Dr. Lehfeldt. Prof. D. Jahn has recently published measurements of E.M.F.'s of concentration cells, from which he has endeavoured to show that the law of dilution is applicable to strong solutions. The author points out that his conclusions are based on argument in a circle because Ostwald's law is assumed in the formula used by Jahn for calculating degrees of concentration. The formulæ of Nernst and Arrhenius do not yield consistent results, and it is suggested that the former is suitable for calculating concentrations and the latter for calculating osmotic pressures.—A paper on the mechanism of radiation was read by Mr. J. H. Jeans. This paper contains an attempt to obtain answers to two questions:—(1) What inferences can be drawn as to the mechanism by which radiation is emitted from an examination of the formula of physical optics? and (2) Is it possible, with the help of these inferences, to frame any conception of matter which will give a consistent account of the various optical phenomena? Starting with general spectroscopy, the author has written down the radiation due to a single rotating molecule vibrating harmonically. The effect of a number of molecules is deduced, and it is shown that the condition that the continuous banded spectrum shall be absent is that either the period of rotation must be large compared with the period of vibration or the radiation from a molecule must be spherically symmetrical. Passing on to dispersion, even if the radiation is continuous between collisions, there will be a discontinuity at every collision and the train of waves will be no longer regular. It is customary to assume that the vibrations of a dispersing medium are sympathetic with the irregular incident light. The author has calculated the ratio between forced and free vibrations in a prism or grating, and finds that if the dispersion is to be regular the vibrations must be only slightly influenced by collisions, and this requires, as in the former case, that either the period of rotation is large compared with the period of vibration, or the radiation is spherically symmetrical. As this is not the case with molecules the author thinks that the line spectrum is emitted by atoms, that these atoms must be dissociated and that the shape of these atoms is one of spherical symmetry. It is shown that if an atom is an electromagnetic system, similar to a planetary system, then the periods of such an atom would not be fixed and there would be no reason for a line spectrum. The normal atom is therefore regarded as an electrostatic system, with some law of force, other than the inverse square law, holding at interionic distances. Such an atom when at rest would give a pure line spectrum. Rotation of such an atom causes the lines of the spectrum to shift towards the red, and as the rotation is different for different atoms the lines will not only be shifted, but broadened. To calculate the periods of vibration of an atom the author has assumed it to consist of an infinitely great number of infinitely small ions. The spectrum of this consists of a collection of spectrum series each possessing a definite head and capable of explaining doublets, triplets, &c. It is shown that under the action of a magnetic field a line may separate out into approximately equidistant lines, the central lines maintaining its position. In conclusion, the author points to many other physical phenomena which can be explained by the theory described.—The chairman then exhibited some specimens of Jena glass. In describing these, reference was made to a diagram showing the refractive index, dispersion between the C and F lines, and the reciprocal of the dispersive power of any piece of glass. For this latter quantity the symbol "ν" is used, and it was suggested to call it the achromatic refractivity of the glass. The introduction of barium increases the deviation, but leaves the dispersion unaltered. It is possible now to get crown glass with a higher refractive index than flint glass, and this makes it possible to construct an achromatic lens which will also give a flat field. It is usual in making achromatic objectives to make them accurately achromatic for the red and violet rays. A better effect can be obtained by having approximate achromatism throughout the length of the spectrum. This is achieved by matching the irrationality of one glass by means of another and then constructing an achromatic pair with these two glasses. "Telescope crown" and "telescope flint" are two glasses which give similar spectra and approximate achromatism from the red to the violet.—The Society then adjourned until June 28, when the meeting will be held, by the invitation of Prof. W. G. Adams, in the laboratory of King's College.

Geological Society, June 5.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—On the passage of a seam of coal into a seam of dolomite, by Aubrey Strahan. The author was informed by Mr. N. R. Griffith in 1900 that the seven-feet seam of the Wirral Colliery had been found to pass into stone of an unusual character. For a distance of 1600 yards from the shaft this seam was good, and about 4 feet thick. A little farther in bands of stone from 1 to 10 inches thick made their appearance in it, and, gradually increasing in thickness, these bands eventually constituted the whole seam, the last traces of workable coal disappearing at 250 yards from the point where the change first began. The boundary of the barren area has been found for a distance of 1480 yards, and it runs north and south. The stone is at first black, but after weathering it becomes grey, and displays curious structures, among which are pisolitic, or mammillated structures, the intervening spaces being filled with coaly matter. One specimen displays woody tissue filled with dolomite. Analyses by Dr. W. Pollard yield from 18·5 to 13 per cent. of magnesia. The phenomena are not those of a "wash-out," as there is no sign of erosion, but there is proof that the dolomite was formed in almost motionless water, and the conditions appear to have been those under which a tufa would form. It appears to have been formed on a spot to which clastic material scarcely gained access, and which was reached even by vegetable matter in scant quantity and in a finely divided condition.—On some landslips in boulder-clay near Scarborough, by Horace W. Monckton.

EDINBURGH.

Royal Society, June 3.—Dr. Hepburn in the chair.—In a paper on binary fission in the life-history of Ciliata, Dr. J. Y. Simpson gave excerpts from statistics of two months' cultures of *Paramoecium caudatum* showing that under the most natural circumstances attainable binary fission does not proceed with that mechanical regularity that Maupas asserted. Further, experimenting with cultures of *Stylossichia pustulata*, he found with Joukowsky as against Maupas that degeneration after continued division shows itself in a general listlessness, in ebbing of vital energy and decrease of size, rather than in definite nuclear disorganisation, but on the other hand, with Maupas as against Joukowsky, that it is not possible to induce conjugation before puberty. Some Paramœcium monstrosities were described, and microphotographs of living *P. aurelia* and *P. caudatum* were shown, establishing the existence of the two species which had recently been called in question.—Dr. E. G. Coker communicated a paper in which were described his various forms of apparatus for measuring strain and applying stress, together with a great many measurements made by means of them. The aim in all was to have the different parts of the measuring apparatus attached to the specimen itself; and probably the most ingenious arrangement was the device for applying and measuring the effects of combined bending and twisting. Another combination was longitudinal stretch and twist. The influence of the one kind of strain upon the elastic relations of the other kind were carefully investigated, especially in the neighbourhood of the yield-point. The behaviour of iron and steel bars when subjected to strain cycles was also studied, and other important questions connected with hysteresis, fatigue and recovery in time.—Mr. W. E. Collinge communicated a paper on the anatomy of a collection of slugs from North-west Borneo, the general results being as follows. The *Damayantia plecta* of Issel was re-described and some notes given on the anatomy of the new species, *D. carinata*. Two new genera were established, viz., Wiegmannia and Isselentia, with five new species. The *Damayantia smithi* (Cllge. and Godw., Auct.) was shown on anatomical grounds to belong to the genus Collingia. Finally two new species of Veronicella and one of Onchidium were described, and a check list of the known species from Borneo was given.

PARIS.

Academy of Sciences, June 10.—M. Fouqué in the chair.—Studies in neutralisation. On the titration of acids and alkalis of complex function with the aid of colouring matters, by M. Berthelot. A study of the behaviour of some amino-acids towards indicators. Of these glycocoll and leucine are acid to phenolphthalein, alkaline to methyl-orange, and neutral to litmus. The three aminobenzoic acids have a clearly acid function except towards methyl-orange.—The phenomena of calorific convection and the cooling power of liquids, by M. J. Boussinesq.—On the series of Bernoulli, by M. G. Mittag-Leffler.—On the Eulerian incomplete integrals of the second species and the indefinite integrals of the preceding functions, by M. E. Vallier.—On the region of convergence of an infinite integral, by M. E. Phragmén.—On a remarkable invariant of certain transformations realised by self-recording apparatus, by M. Rabut.—The laws of Gay-Lussac and the dissociation of gaseous compounds, by M. A. Ponsot. It is usually held that the law of Avogadro is an approximate law which tends to become more exact as the volume increases. According to the investigation in the present paper this is not the case.—The vibrations produced in a wire with an influence machine, by M. D. Negreano. If an insulated stretched wire contained in a tube is connected with one of the poles of a Wimshurst influence machine, transverse vibrations are set up in the wire, and if viewed in the dark, portions of the wire become visible.—On an electrolytic rectifier, by M. Ch. Pollak. A description of the conditions under which it is possible to use aluminium electrodes in an electrolytic apparatus for rectifying alternating currents, together with the precautions necessary in forming the plates.—On an electrical grisoumeter, by M. G. Léon. Two small platinum wires forming two of the arms of a Wheatstone's bridge are kept at a red heat by a small battery of accumulators, one of the wires being placed in pure air and the other in the atmosphere containing methane. The presence of the methane causes a rise in the temperature of the latter wire which results in a deflection of the galvanometer, this deflection being proportional to the amount of marsh gas present.—On the experimental verification of a law of chemical mechanics, by M. H. Pélabon. The reaction between hydrogen and mercuric sulphide has been experimentally studied and the results applied to the verification of the formula $p_1p_2/p_3p_4=f(\text{T})$.—The action of a metallic hydrate upon a salt of another metal. Basic salts with two metals, by M. A. Recoura. Results of experiments upon the reactions between copper hydrate upon solutions of zinc sulphate, and of the sulphates of cadmium, manganese, cobalt, nickel and copper.—On the imidodithiocarbonic esters, $RN:C(SR')_2$, by M. Marcel Delépine.—On the active erythritols, by MM. L. Maquenne and G. Bertrand. Measurements of the rotatory power of the two erythritols in water and in alcohol, and description of the preparation of the tetra-acetyl, benzoyl and valeryl derivatives, and also of the oxidation products.—Study of a densimeter for the determination of the baking value of wheaten flour, by M. E. Fleurent.—Analysis of some travertines from the Vichy basin, by MM. C. Girard and F. Bordas.—On the olivine gabbro from Kosswinsky-Kamen (Ural), by MM. L. Duparc and F. Pearce.—On the function of the eustatic oscillations of the level of the base in the formation of systems of terraces in some valleys, by M. D. Lamothe.—On the morphology of the sexual elements in some species of Stylorhynchus by M. Louis Léger.—On the constant presence of a gregariniform stage in the cycle of evolution of hematozoa of malaria, by M. A. Billet.—New observations on the parthenogenesis of the sea urchin, by M. G. Viguier.—On the use of silicotungstic acid as a reagent for the alkaloids of urine. The variations of alkaloidal nitrogen, by M. H. Guillemard. The ratio of the alkaloidal nitrogen to the total nitrogen existing in urine varies to some extent with the food, but in certain febrile diseases this ratio undergoes enormous variations, there being in the latter case a considerable increase in both the absolute and relative quantities of the alkaloids eliminated.—On the otoliths of the frog, by M. Marage.—On a new method of examination for the typhoid bacillus, by M. R. Cambier. It is found that if a sterile broth contained in a tube of biscuit porcelain, which latter dips also into sterile broth, is inoculated with the typhoid bacillus, in the course of its growth the bacillus is able to make its way through the porcelain, even although this same porcelain is quite capable of filtering off the bacillus in the ordinary way. It was found that the more actively motile the bacillus the more easily was the filter penetrated in this way. Several other species of bacilli were found to be capable of traversing the walls of the filter in a similar way, but none of the species examined up to the present pass through so rapidly as the typhoid bacillus. On the basis of these observations the author founds a method of determining the presence of this bacillus in potable water, and he has been able to recognise the Ebert bacillus in water from the Seine and the Marne and also in the waters from certain springs.—Six months' meteorological observations at Quito, by M. F. Gonnessiat.

DIARY OF SOCIETIES.

THURSDAY, JUNE 20.

ROYAL SOCIETY, at 4.30.—The Nature and Origin of the Poison of *Lotus arabicus*: W. R. Dunstan, F.R.S., and T. A. Henry.—(1) On the Mathematical Theory of Errors of Judgment, with Special Reference to the Personal Equation; (2) Mathematical Contributions to the Theory of Evolution. X. Supplement to a Memoir on Skew Variation: Prof. K. Pearson, F.R.S.—On the Application of Maxwell's Curves to Three-Colour Work, with Especial Reference to the Nature of the Inks to be employed, and to the Determination of the Suitable Light-filters: Dr. R. S. Clay.—On the Structure and Affinities of *Dipteris*, with Notes on the Geological History of the Dipteridinæ: A. C. Seward, F.R.S., and Miss E. Dale.—(1) Further Observations on Nova Persei, No. 3; (2) Total Eclipse of the Sun, May 28, 1900: Account of the Observations made by the Solar Physics Observatory Eclipse Expedition and the Officers and Men of H.M.S. *Theseus*, at Santa Pola, Spain: Sir Norman Lockyer, K.C.B., F.R.S.—The Mechanism of the Electric Arc: Mrs. H. Ayrton.—And other Papers.

LINNEAN SOCIETY, at 8.—On the Freshwater Algæ of Ceylon: W. West and G. S. West.—On Coprophilous Fungi: George Massee and E. Salmon.—Revision of the Genus Hypericophyllum, Steetz, with Notes on certain Genera with which it has been confused: N. E. Brown.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Direct Union of Carbon and Hydrogen, Part II.: W. A. Bone and D. S. Jerdan.—Ammonium and other Imidosulphites: E. Divers and M. Ogawa.—Nitrilosulphates: E. Divers and T. Haga.—The Decomposition of Hydrocarbons at High Temperatures: W. A. Bone and D. S Jerdan.—The Sugars from Cellulose: H. J. H. Fenton.—On a Theory of Chemical Combination: G. Martin.—On the Occurrence of Paraffins in the Leaf of Tobacco: Dr. T. E. Thorpe, C.B., F.R.S., and John Holmes.—Studies in the Camphane Series, Part IV.: M. O. Forster.—On the Decomposition of Carbon Dioxide, when submitted to Electric Discharge at Low Pressures: Dr. J. N. Collie, F.R.S.—Two New Substances in Lemon Oil: H. E. Burgess.

MONDAY, JUNE 24.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Belgian Antarctic Expedition: Henryk Arçtowski.

CONTENTS.

THURSDAY, JUNE 27, 1901.

STUDIES IN COMPARATIVE RELIGION.

The Golden Bough: a Study in Magic and Religion. By J. G. Frazer, D.C.L., LL.D., Litt.D. Second Edition. Revised and enlarged. Three volumes. Vol. i., pp. xxviii + 467; vol. ii., pp. x + 471; vol. iii., pp. x + 490. (London: Macmillan and Co., Ltd., 1900.) Price 30*s*. net.

WITHIN recent years few books have exercised more influence on the study of comparative religion than Mr. Frazer's "Golden Bough," the first edition of which appeared in 1890. Working in the main on the lines laid down by Prof. E. B. Tylor, he applied the results obtained from a prolonged study of the beliefs and practices of primitive races to explain the meaning and origin of a strange rule of an ancient Italian priesthood. Near the lake of Nemi in the Alban hills, at some distance from the ancient town of Aricia, stood a grove and sanctuary sacred to Diana, and the strange rule of the priesthood attached to the grove finds no parallel in classical antiquity. The priest, who bore the title of "King of the Wood," watched night and day with a drawn sword, always ready to defend his life against the attack of a possible assailant. A candidate for the priesthood had first to break off a bough from a certain tree in the wood, and, if successful, he was entitled to fight the priest in single combat; should he slay the priest he reigned in his stead until he in his turn was slain. Mr. Frazer's book takes its title from the tradition that the branch guarded by the priest was the Golden Bough which Æneas plucked before he attempted his journey to the realm of the dead. Put briefly, Mr. Frazer's explanation of the rule amounts to this: the King of the Wood was an incarnation of the tree-spirit, or spirit of vegetation, which was also inherent in the Golden Bough, or mistletoe, growing on the tree, probably an oak, in the Arician grove. The only way of preserving the tree-spirit from decay necessitated the priest's violent death; the divine life by this means was transferred to a suitable successor—that is to say, to the stronger man who should slay him. But in his character of a tree-spirit, the priest's life was bound up with that of the mistletoe on the tree; hence it was necessary for the slayer first to break the Golden Bough. The exposition of this theory furnished the thread on which Mr. Frazer skilfully arranged a series of exhaustive essays dealing with many phases of primitive superstition and belief.

In our review of the first edition of the book (see NATURE, September 25, 1890, vol. xlii. pp. 513 ff.) we described in detail the various steps in Mr. Frazer's argument, and we shall not, therefore, go over the same ground again, but rather confine ourselves to noticing the most important additions which Mr. Frazer has incorporated. The book has been considerably expanded, for it now consists of three instead of two volumes, and a rather smaller type has been used. The system of arrangement and the division into four chapters has been retained, but there are few parts of the work to which considerable additions have not been made. During the ten years that have elapsed since the publication of the first edition, most valuable researches have been carried on by Messrs. Spencer and Gillen in Central Australia, by Mr. Skeat in the Malay Peninsula, by Mr. van der Toorn in Sumatra, and by the late Miss Kingsley in West Africa, to mention but a few names among the growing band of practical anthropologists; and the store of new material thus collected has furnished Mr. Frazer with a host of fresh examples to illustrate his theory. Great advances have also been made in our knowledge of the ancient Egyptian and Babylonian religions, and Mr. Frazer has availed himself of the recently published works on these subjects. Such additions have considerably increased the subsidiary and illustrative portions of the book, but they only affect the main argument in so far as they furnish additional proofs and instances. Two sections, however, have not only been expanded, but have been recast and rewritten, and with these we propose to deal in greater detail. In the first edition a short section of a few pages was devoted to a description of primitive man and his conception of things supernatural; in the second edition this has been expanded into a regular treatise, in which Mr. Frazer for the first time formulates his theory of the relation of magic to religion. Again, in the first edition the author only hinted at the bearing which his researches might have upon some of the central tenets of the Christian religion; in the second edition he has worked out his theory in detail.

Speaking broadly, Mr. Frazer has come into line with the majority of anthropologists and students of religion in regarding magic and religion as totally distinct from one another, the former representing a lower intellectual stratum which has probably everywhere preceded the latter. When writing his first edition, Mr. Frazer tells us, he did not accurately define, even to himself, his notion of religion, and he was disposed to class magic loosely under it as one of its lower forms. He has now framed his definition of religion, not by collecting the opinions of the learned on the subject, but directly from his own study of the facts. Mr. Frazer's position among contemporary writers would ensure for any view he might propound the most careful study and consideration; we note with the greater pleasure, therefore, that his mature opinion on the relation of magic to religion does not necessitate the recasting of the theory at present in the field. In his opinion the movement of man's thought has, on the whole, been from magic, through religion, to science. In magic man depends on his own strength to meet the difficulties and dangers that beset him. He believes in an established order of nature which by certain actions of his own (*i.e.* magic) he can manipulate for his own ends. When he discovers his mistake and finds he cannot control nature as he believed, he ceases to rely on his own unaided efforts and ascribes to certain great invisible beings behind the veil of nature the far-reaching powers which he once arrogated to himself. Thus magic is gradually superseded by religion, and natural phenomena are believed to be regulated by beings who are like men in kind and are swayed by human passions, but are endowed by powers vastly superior to his. As time goes on this explanation in its turn proves unsatisfactory. The longer nature is studied the succession of natural events appears less and less variable and irregular.

"The keener minds," writes Mr. Frazer, "still pressing forward to a deeper solution of the mysteries of the universe, come to reject the religious theory of nature as inadequate, and to revert in a measure to the older standpoint of magic by postulating explicitly what in magic had only been implicitly assumed, to wit, an inflexible regularity in the order of natural events, which, if carefully observed, enables us to foresee their course with certainty and to act accordingly. In short, religion, regarded as an explanation of nature, is displaced by science."

We have here a sane and consistent theory of the progress of human thought, and we wish we had space to quote at greater length; for further details we must, however, refer the reader to the book itself.

In passing to the section which treats of "The Saturnalia and Kindred Festivals" we come upon more debatable ground. Here Mr. Frazer has expanded his theory of the general prevalence of the custom of killing a human god, so as to include, and to some extent explain, the crucifixion of Christ. We may say at once that we hold no brief for the orthodox view with regard to that event, and, if the evidence tended to prove that the crucifixion, with the mockery which preceded it, was not a punishment specially devised for Christ but merely the fate which annually befell a malefactor who played the part of a mock king during a sort of Saturnalia, there would be no reason, so far as we are concerned, why the theory should not be accepted. Mr. Andrew Lang, in the character of a champion of orthodoxy, has already made an onslaught upon Mr. Frazer, and we have no intention of following his example or of adopting his methods of controversy. But to our thinking Mr. Frazer has in this portion of his book been induced to abandon his excellent practice of following his evidence, and has considerably outrun it.

In his explanation of the rule of the Arician priesthood Mr. Frazer infers that at an earlier period one of the priests had probably been slain every year in the character of an incarnate deity. In his first edition the only parallel case he could cite was the custom of killing a human god annually in ancient Mexico. Now from a narrative of the martyrdom of St. Dasius, published by Prof. Cumont in 1897, it would seem that at the celebration of the Saturnalia the King, or Lord of Misrule, had not always been a mere clown, but that at one time it was the custom, after a riotous rule of thirty days, that he should put himself to death. This new piece of evidence Mr. Frazer justly claims as a striking confirmation of his theory with regard to the Arician priesthood, but it does not prove, or render likely, the extensive prevalence in the East of the custom of annually killing a human god which his theory of the crucifixion presupposes.

There is some evidence that during the late period of Babylonian history, after the Persian conquest, an annual feast took place in Babylon termed the Sacæa, which resembled the Saturnalia in that masters and servants changed places and a mock king presided over the revels. The evidence for the festival consists of a quotation by Athenæus from Berosus, while Dio Chrysostom, quoting probably from Berosus or Ctesias, adds the additional detail that the mock king was subsequently executed. Dr. Bruno Meissner has conjectured that the Sacæa may have corresponded to Zag-muk, the Babylonian festival of the New Year. We still know very little about the manner in which Zag-muk was celebrated, but, in spite of a difficulty of dates, it is possible that Sacæa was a late form of that festival. Moreover, the Jewish feast of Purim, the earliest references to which occur in Esther and the second book of Maccabees, was probably borrowed by the Jews during their captivity, and may well have been taken from the Babylonian Zag-muk, as Prof. Zimmern, of Leipzig, has suggested. There is no doubt that both Zag-muk and Purim were celebrated with feasting and revelry; but Mr. Frazer goes further, and would find in the account of the institution of Purim in the book of Esther traces of the slaying of a mock king such as, according to Dio Chrysostom, took place at the Sacæa.

It will be remembered that the book of Esther describes the rivalry between Haman, the vizier of Ahasuerus (probably a corruption of *Khshayārsha*, *i.e.*, Xerxes), King of Persia, and the Jew Mordecai; it relates how the Jews, when doomed to destruction through Haman's influence, were delivered by the Queen Esther and her uncle Mordecai, and how Haman perished on the gallows he had prepared for his rival. Prof. Jensen, of Marburg, has recently formulated a theory that the names Haman and Vashti are those of an Elamite god and goddess, and that Mordecai and Esther are the Babylonian deities Marduk and Ishtar; and, further, that the story reflects an antagonism between the gods of Elam and the gods of Babylon. Mr. Frazer accepts the identifications, and in the story of the death of Haman on the gallows sees a further reflection of the custom of slaying a man in the character of a god. He thinks that such human sacrifice formed part of the original rites of the feast of Purim, and was probably derived from some similar rite among the Babylonians. In the burning of effigies of Haman at the feast of Purim by the later Jews he sees a survival of this human sacrifice. The rite he explains, on lines already familiar to his readers, as a magical ceremony intended to ensure the revival and reproduction of life in spring.

In such ceremonies elsewhere the man-god dies only a mimic death and then rises again, or else he was actually slain and was thought to live in the person of a successor who took his place. In the Esther story Mr. Frazer suggests that Mordecai represents the second temporary king, who, on the death of his predecessor, was invested with the royal insignia and exhibited to the people as the god come to life again. In Vashti and Esther he sees the divine consorts of the mock kings during their brief periods of rule. In this way he explains the story of the struggle between Haman and Vashti, on the one side, and their doubles, Mordecai and Esther, on the other:

"Both pairs stood for the fertility of plants and perhaps of animals; but the one pair embodied the failing energies of the past, the other the vigorous and growing energies of the coming year."

In the original form of the rite from which Mr. Frazer supposes the feast of Purim to be derived, he suggests that the Babylonian king was the actual victim who was put to death each year, but that subsequently a substitute was always found in one of his sons, or a slave, or a malefactor. His period of rule was also curtailed from a year to a few days each year.

Now the details of the crucifixion present some resemblance to the treatment of the mock king in the Sacæa. Both victims were clothed in fine raiment and crowned as kings, and afterwards scourged aud crucified. This, Mr. Frazer thinks, is not a chance resemblance. The Jewish feast of Purim may have been derived from Zag-muk, which in turn may possibly be identified with the Sacæa; and he suggests that the Jews in the time of Christ may have every year at the feast of Purim compelled a condemned criminal to play the part of Haman and be put to death, in the same way as their later descendants destroyed effigies of him. Briefly, Mr. Frazer's theory is that Christ was put to death as one of these yearly victims. That the crucifixion took place at Passover, *i.e.* a month after the Feast of Purim, he thinks may be explained by supposing that Christian tradition for purposes of edification shifted the date of the crucifixion from Purim in order to make the sacrifice coincide with the annual sacrifice of the Passover lamb. He offers the alternative suggestions that the Jews may have sometimes celebrated Purim at about the time of the Passover (*i.e.* in Nisan) in consequence of its derivation from the Babylonian Zag-muk, which was held in Nisan; or, finally, the Jews may have spared the victim of the feast of Purim for one month, when his death would occur at Passover. Thus, according to Mr. Frazer, Christ was crucified and Barabbas was released as part of the passion-play performed each year by the Jews at Purim. They took the parts of Haman and Mordecai respectively, and at the end of the performance the one who played Haman was crucified, and the other, who personated Mordecai, was allowed to go free. Following out his theory, Mr. Frazer suggests that the name Barabbas, "Son of the Father," was not the name of an individual, but was the title given to one or both of the actors in the play. Similarly, the description of Christ's triumphal ride into Jerusalem before his death, and the account of the raid he made afterwards upon the stalls of the money-changers in the temple, he thinks may perhaps be traced to those arbitrary rights over property which it has been customary to accord to such temporary kings during their brief period of rule. The hero of the drama, in fact, may have been "no more than a moral teacher whom the fortunate accident of his execution invested with a crown not merely of a martyr, but of a god."

Such is Mr. Frazer's theory, and we confess to feeling that, unlike the rest of his book, this section contains a great deal of theory and very little evidence. That the rites of the late Sacæa were identical with those of the earlier Babylonian Zag-muk is pure assumption; and that a Babylonian king was at one time annually slain is unsupported by any evidence, whereas had this been the case the custom must have left some trace in the Babylonian literature. Prof. Jensen's identification of the principal personages mentioned in Esther with Elamite and Babylonian deities is, to say the least, a little fanciful, and still more fanciful is Mr. Frazer's improvement on his theory; it is hard to recognise in the story a reflection of a passion play. Finally, the question of dates is a real difficulty of which not one of Mr. Frazer's alternative theories successfully disposes. After careful study we think it easier to explain the resemblance of Christ's crucifixion to the rites of the Sacæa as the result of coincidence rather than to accept the artificial theory we have summarised. Moreover, with a strange absence of logic Mr. Frazer claims that his theory sheds "fresh light on some of the causes which contributed to the remarkably rapid diffusion of Christianity in Asia Minor"; as a matter of fact, it does the reverse. The political significance of Christ's martyrdom and the prominence it consequently gave his following form the simplest explanation of the rapid spread of Christianity. The more ordinary and normal the crucifixion is represented the harder it is to understand the problem; Mr. Frazer's theory reduces the crucifixion to an annual event.

We have dealt in some detail with the two chief novelties of the second edition of the work; our criticism of one theory, however, should not be taken as detracting in any way from the general value of the book, which will always form a storehouse of facts for the student of religion, and which will surely influence for many years the work of those who concern themselves with that wide and attractive field of study.

THE ISLAND OF CELEBES.

Über die geologische Geschichte der Insel Celebes auf Grund der Thierverbreitung. Von Dr. Paul Sarasin und Dr. Fritz Sarasin. Pp. vi + 169; 15 plates. (Wiesbaden: Kreidel, 1901.)

THE island of Celebes, as is well known, is comparable in a metaphorical sense to one of the floating islands of antiquity; it has not definitely come to rest in either the Australian or the Oriental region. By some authorities its marsupial inhabitants are held to outweigh in importance its likeness in other respects to the islands of the Malayan archipelago, and it is associated with Mr. Sclater's Australian region; others, again, place it as definitely with the Oriental region; while its anomalous and intermediate character has led not a few to fatal hesitation and to consequent abandonment of the problem. The authors of the volume before us dismiss at once, and with some brusqueness, all consideration of this matter. The chief problem of geographical distribution is for them not "whether Celebes belongs to the Oriental or to the Australian region, but what are the land connections, and of what epoch, which must be assumed to account for the condition of its fauna to-day?" This attitude of mind shows a healthy reaction against the elaborate method adopted by many zoogeographers of late years. The detailed planning and plotting out of the globe into a complicated series of regions, subregions and provinces is not, in the opinion of the present writer, of great usefulness save in so far as it allows of a rapid and perhaps graphic method of indicating the range of a particular animal. The two authors proceed further to observe that it is better to select, for the purposes of such problems as are presented by Celebes, species and not genera of animals; and this on the perfectly reasonable grounds that while the limits of genera are most diversely regarded, there is not, at least, so much difference of opinion as to the limits of a species. They are thus a safer indication of both likenesses and differences in two faunas. Mr. Sclater, some years ago, proposed the term of "lipotype" to express a negative state of affairs; a genus or species which was, as it were, unaccountably absent from a given region was thus denominated.

There is no doubt that this expression was wanted and that it did emphasise important zoogeographical fact. Nevertheless, it must be used with care, especially with regard to smaller and less conspicuous creatures. The Drs. Sarasin instance the case of the land planarians of Celebes. It was written so recently as 1891 that not a single species of this group of Platyhelminthes had been found in Celebes. Now we are acquainted with quite a number of forms, so much so that Celebes is the second richest island of the whole Malayan archipelago in these worms. We are glad to notice that the authors carefully distinguish between artificial introduction of species and introduction by natural means. To this matter attention has not, perhaps, been sufficiently drawn, and the wide range of many small creatures which has been used as an argument for their antiquity and has been generally made use of by the zoogeographer has not always the real value that has been attached to it. After due sifting of such fraudulent claimants to indigeneity the authors are, roughly speaking, disposed to do what has been mocked at—to demand a continent to explain the range of a beetle. Avoiding exaggeration, we can assert that the authors are not at all impressed by the floating log *deus ex machinâ;* they think that similar inhabitants on opposite sides of a sea generally imply a former land connection.

It will be noted from the few observations made that the authors preface their detailed consideration of the fauna of Celebes and neighbouring islands with some remarks of a general nature, which might perhaps have been rather more expanded if the work had not been of so special a character. The animal groups made use of by the authors are chiefly the molluscs, reptiles and amphibians; birds, mammals and land planarians are not neglected. The fact that there are more peculiar species of molluscs than of reptiles and amphibians is commented upon; this the authors attribute to the greater mobility of the two vertebrate groups. In discussing all zoological characteristics of Celebes it must be borne in mind, as is duly pointed out on p. 128, that the island itself first rose from the waves after Eocene times, for a great mass of the solid rock of which it is built is Eocene chalk. The view of its subsequent history which the fauna appears to indicate is that it first showed itself above the water in the Miocene and that during the Pliocene it was in connection with neighbouring islands, from which it became subsequently and at different times detached. It is justly described, therefore, as a "fragment of a Miocene continent." One important exception, however, exists to the statement that Celebes has been in the past in connection with the other islands of the surrounding seas. The authors point out that there is not a single species of animal known to be common to Celebes and Borneo and not at the same time found in some of the other islands; this, as is justly inferred, seems to indicate that Celebes can never have been connected by a land bridge with Borneo directly, though, of course, it probably was indirectly by way of Java, on the one hand, and possibly (though the authors think not) the Philippines on the other. The Macassar strait thus represents a tract of ocean which has been water before and since the appearance of Celebes upon the earth's surface. On the other hand, the supposed deep channel on the south intervening between Bali and Lombok is, as it appears from Prof. Max Weber's soundings, to be given up, since the greatest depth then ascertained to exist was merely 312 metres. This volume is of extreme interest as a detailed attempt to reconstruct from a comparison of faunas the past geological history of a group of islands. It is abundantly illustrated with maps, and concludes with an historical review of the literature of the subject and a list of memoirs and books.

F. E. B.

ENGINEERING EDUCATION.

Proceedings of the Eighth Annual Meeting of the Society for the Promotion of Engineering Education held in New York City, July 2–3, 1900. Vol. viii. Pp. xxviii + 377. (New York: Engineering News Publishing Company, 1900.) Price 2.50 dollars.

WHEN technical education is so much in the air, and so many consider that it is a cure for all our industrial troubles, it is interesting to see what another nation thinks of its own system of education. In America there exists a society for the promotion of engineering education, and we have the pleasure of reading their eighth volume of *Proceedings*—that of last year. The members of this association are those who are, or have been, engaged in responsible positions in the work of engineering instruction. There is a regular meeting for several days once every year, the whole of the papers which are read dealing with education as applied to industry.

The association seems to be most prosperous, both financially and in point of numbers; it is clear that meeting together of teachers is most useful to both teachers and students, and it is to be hoped that in this country a similar society may be formed, which would do much to educate public opinion as to what technical education exactly means. At present very few people understand what is wanted to be taught and whom to teach it to; an individual, even of the most impressive powers and personality, cannot speak with the same authority as a society which has only one end, namely, to improve our educational methods.

The presidential address of Prof. Ira D. Barker, dealing with the position of engineering education in the United States at the end of the century, is most instructive in showing what a strong hold technical instruction has on the other side of the Atlantic.

At the end of 1899 there were eighty-nine institutions offering full courses in engineering, in some cases seven different courses being open to students, the numbers attending full courses being 9679; of these colleges no less than 98 per cent. require the four years' course before graduation.

These schools must not in any way be considered as falling into the same category as our technical schools, which mainly address themselves to evening work for the artisan class. No doubt our technical schools do excellent work, but they in no way give that thorough and systematic instruction which is given in the American colleges, which do not wish to produce workmen, but to train successful leaders of industry. The trade school, which seems to have become inevitable in all countries under the stress of modern industrial competition, is evidently making its way in America, but, unlike us, no attempt is made to teach a boy a trade in his spare hours during the evening, but attendance is required during his entire time. The course really forms a part of the high school curriculum, and, while not developed to the same extent as in Germany, it is clear that Americans look to some such school to give that training which was in olden days given to the apprentice, but which will soon have become impossible to acquire in a modern works.

Perhaps the most interesting paper in the *Proceedings* is one by a committee on American industrial education. Great prominence is given to the manual training method, not only for kindergarten work, but for all grades of education up to the highest; as is there stated, the system is costly, but the results are said to be calculated to astonish those who have never seen the manual training system in operation.

The agricultural and mechanical colleges, founded in the first instance by land grant bills, are evidently the backbone of American education as regards applied science. Some colleges, such as Cornell, have developed in all directions, while others have confined their scope to purely practical subjects.

In all cases the instruction is based on a wide basis of those pure sciences which are the foundation of all technical knowledge. The Americans go further than we do, and give up a part of the course to purely literary subjects in order to give a broader education.

The correspondence technical schools are probably peculiar to America and are of quite a recent date; they are purely private concerns, which offer to give complete instruction by a course of papers. As the committee remark, the majority of students who commence soon drop the courses, but the convenience of learning by post is considered so great that these correspondence classes will probably become permanent.

The night school system is condemned by the committee in a most positive manner. The learner starts to learn after a heavy day's work, and after the classes are finished mind and body are alike exhausted.

No systematic course of study is possible owing to lack of time, while the whole atmosphere of the school is said to be very far from stimulating and encouraging. We are quite in agreement with this committee on this subject, and wish that people would not place so much reliance on the work of evening classes.

We conclude with an extract from some remarks made by Prof. Alderson, of Lafayette, Miss.:—

"Those who have had an opportunity to look into this matter probably know full well that to-day the industrial decadence of England is due to her failure to recognise the proper status of engineering education."

Such remarks are not pleasant reading, but often a dose of bitter truth is beneficial. Let us hope that it may not be too late for the warning to be of service.

F. W. Burstall.

OUR BOOK SHELF.

Chemical Technology; or, Chemistry in its Applications to Arts and Manufactures. Edited by C. E. Groves and W. Thorp. Vol. iii. *Gas Lighting.* By Charles Hunt. Pp. xviii + 312. (London: J. and A. Churchill, 1900.) Price 18*s*.

This, the third volume of a well-known work on chemical technology, gives a history of the manufacture of gas and its application to the purposes of illumination. After a short historical introduction, about three-quarters of the remainder of the book is occupied with a description of the mode of manufacture, purification and distribution of coal gas as carried out in this country. The consideration of gas burners then takes some fifty pages, the questions of the testing, analysis and determination of the heat of combustion of gas occupying about twenty pages. The apparatus used in the manufacture of coal gas is described in great detail, chapters being devoted to the construction and use of retorts, furnaces (several regenerative furnaces being described in this section), stoking machinery, condensers and scrubbers, purifiers, the measurement and storage of gas—the numerous forms of gasholders being very fully given—governors, distributing mains and pipes, and gas meters.

The mode of treatment throughout is that of an engineer, or rather a gas engineer, writing for gas engineers, and as representing the wide experience of the author in this respect the work will doubtless be found necessary on the bookshelves of every manager of a gasworks. The only criticism which may be offered in this respect is that the question of water-gas manufacture and distribution is not treated with the fulness which the growing importance of the subject deserves, a defect which may perhaps be attributed to the fact that it is only within the last year or two that public attention has been drawn to this subject by the agitation of certain public authorities against the use of this gas, and the subsequent appointment of a committee of the Board of Trade to consider the matter. From the absence of any mention of this, and from other indications, it is clear that the book was completed some two years before the date of publication. Thus the limits of sulphur impurity allowed in the metropolis are incorrectly stated, and no mention is made of the complete alteration in the method of testing London gas prescribed by the London Gas Referees in 1898.

But a more serious objection is the mode of treatment of the subject as a whole. As one of a series of chemical handbooks, it is natural to expect that the subject would be treated from a chemical, or at all events from a scientific, as opposed to an empirical, point of view, and this is by no means the case. The growth of gas manufacture in this country has been essentially empirical, and, although dealing with a chemical manufacture, has been developed almost exclusively by engineers without any special chemical knowledge. This is faithfully mirrored in the work under notice, in which mechanical details are given with minute accuracy, but chemical details are alluded to very briefly. Incidental references are made to the modes of analysing coal gas at various stages of its purification, although even here preference seems to be given in gasworks to rough and empirical apparatus. It is noteworthy that whilst the title of the book is "Gas Lighting," the question of photometry is altogether omitted; and although, as mentioned in the earlier chapters, the temperature at which the coal is distilled is of supreme importance as regards its quality and quantity, no mention is made of the use of any form of high temperature thermometer, nor, judging from the present work, does the pyrometer seem to be regarded as an essential part of the equipment of a gasworks.

There is still room for a work on coal gas which shall treat of the subject from a scientific as opposed to the empirical standpoint.

Elements of Quaternions. By Sir W. Hamilton. 2nd edition. Edited by C. J. Joly. Vol. ii. Pp. liv + 502. (London: Longmans and Co., 1901.) Price 21*s.* net.

THIS being the second volume of the reprint of a book that has become classical, and is known, by reputation at least, to all mathematicians, it is unnecessary to review it at much length. A comparison, however, seems to be called for between the work of the master and that published by his great disciple, Prof. Tait, since the first edition of the "Elements" made its appearance. The methods of treatment adopted differ radically. Prof. Tait's book is "essentially a working one," and for the most part contains only those formulæ that are necessary to a student when he commences the study of quaternions, and will afterwards be his working formulæ for general use. Sir W. Hamilton's book, on the other hand, aims at completeness. It gives fifty-three transformations for the vector of torsion of a curve in space, and treats the whole of the theory of curves and surfaces with the same elaboration! This wealth of methods and formulæ, which will only confuse the student who wishes to learn quaternions merely in order to apply it in his investigations in physics, &c., makes the book indispensable to the student who studies the subject for its own sake, or who wishes to deepen or consolidate the knowledge of it that he already possesses. Hamilton passes over statics and rigid dynamics quickly, but he treats dynamics and Fresnel's wave surface with his usual fulness.

About a quarter of this volume is occupied by notes by Prof. Joly. Among these are some on the invariants of linear vector functions, on the tri-linear function, and on the kinematical treatment of curves and surfaces. There is a long note on the operator ∇, a symbol which Hamilton does not use in the "Elements." These notes are very valuable, both because they bring the work up to date, and because they are very suggestive of fields for original investigation. We regret that mention is not made of the properties of the quaternion that is the sum of the vector and scalar potentials in the case of irrotational fluid motion, &c., and that several useful words, such as "curl," "convergence," "vector potential" are little used. No mention is made of the notation (f, g, h) for a vector.

A difficulty under which quaternions at present suffers is that, on the one hand, a worker in a branch of applied mathematics does not care to publish papers in quaternion notation for fear that few will understand him; and, on the other hand, that the lack of such papers discourages the study of quaternions. The notation just referred to seems likely to afford a convenient bridge between Cartesians and quaternions. An investigation of the electromagnetic wave surface by Prof. Tait is quoted in a footnote. It might have been added that the surface was first found by Heaviside. The omission is no doubt due to Heaviside's use of vector algebra, but it is perhaps allowable to consider the latter to be quaternions written in a modified (but not improved) notation. H. C. P.

Our Country's Shells and How to Know Them: a Guide to the British Mollusca. By W. J. Gordon. Illustrated by A. Lambert. Pp. vii + 152. Thirty-three coloured plates. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd.) Price 6*s.*

COLLECTORS of British shells will find this volume very useful for reference. The plates include coloured pictures of all our mollusca having shells, drawn life size in most cases, and also representatives of each genus without shells. Analytical tables are given to facilitate identification, and there are chapters on the habits and structures of the mollusca. If the collection of shells induces students to study the characteristics of the living animals, the book will be a means of education in natural history as well as a convenient reference manual.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Our Mountain Seclusion.

IN these days of continuous railway expansion it is only natural and desirable that our mountain solitudes should be made accessible to the general public. But obviously this praiseworthy object should not be attained by the destruction of the very seclusion which it is proposed to reach. A line of railway, with its cuttings, tunnels, embankments, stations, smoke and noise, will carry us much more swiftly and conveniently into a remote glen than the older and quieter modes of locomotion, but we then find that the charm of loneliness which used to give the glen its special fascination has disappeared. Where this transformation is absolutely necessary for the general benefit of the public we must submit to it, though with a sigh. But where the necessity or even the advantage may be disputed, surely the beauty or grandeur or solitude of untouched and unspoiled nature ought to be allowed to have a potent influence in the decision of such matters.

I have just heard of an assault at present being waged against the sanctities of Snowdon, and though it may be impracticable to ward off or mitigate that assault, and possibly too late, even if originally practicable, the attention of all lovers of scenery and of all geologists may well be drawn to it. A bill which has been introduced into Parliament for the construction of the Portmadoc, Beddgelert and South Snowdon Electric Railway, or Tramway, has passed the House of Lords and the Examiners in the House of Commons. If the line is ultimately sanctioned it will greatly lessen the quiet beauty of one of the loveliest and most secluded scenes in Britain—the easily accessible valley on the south side of Snowdon. I understand that, as the result of pressure, the Company has given way with reference to a proposed embankment in the Pass of Aberglaslyn, and will content itself with a brief disappearance in a tunnel. But geologists will learn with vexation that one important part of the scheme consists in the embanking of that picturesque mountain tarn, Llyn Llydaw, for the purpose of obtaining water-power. I need not refer to the special interest and importance of this lake-basin in questions of glacial and physiographical geology. Though it has long been studied, it has not yet yielded up all that it has to tell in these departments of science. But the transformation proposed to be effected by the company will silence it for ever by destroying the evidence which it can now afford.

Can nothing be yet done to save this geological sanctuary from the vandalism of the modern company promoter?

June 22. ARCH. GEIKIE.

The National Antarctic Expedition.

THERE is one allusion in the article on the above subject last week which calls for a few words from me. I refer to the first introduction of the word "civilian." Through the kindness of a friend I have recently had the opportunity of seeing a copy of the agenda. The agenda correspond with the minutes, and the word "civilian" is used in both. I had myself forwarded the motion concerning the scientific leadership to the secretary to be put on the agenda, and the word "civilian" certainly had no place in my communication.

At the meeting I moved, and Prof. Herdman seconded, the motion in the terms of my original communication, and neither of us noticed the change on the agenda paper.

We must therefore plead guilty to some carelessness and inattention; but the argument in my letter to the Fellows of the Royal Society is not seriously affected. An important change, exceeding the instructions drawn up for the guidance of the Executive Committee, is not, on any reasonable view, properly introduced by a single word which appears in the agenda and is not noticed or used by the mover and seconder of the motion. So important a question of principle obviously demanded very special discussion.

June 22. EDWARD B. POULTON.

Stress—Its Definition.

THE important word *stress*, denoting a fundamental conception in dynamics, is one as to the meaning of which no haziness or doubt ought to be permitted by the scientific community.

In your review of Prof. Gray's "Physics," the reviewer criticises the use made of the word in question, and makes the statement: "Strictly a stress is measured by the force applied per unit of area; it has the dimensions of force divided by the square of a length. . . ."

No authority is quoted to justify this statement. Does such authority exist? On collating the statements regarding the meaning to be attached to the word in some of the most authoritative works in the language, I have found a considerable want of agreement.

Going back to Rankine, who is credited with having introduced the word *stress* as a technical term into mechanics, we find the following paragraph in his paper "On Axes of Elasticity and Crystalline Forms" (1855):

"In this paper the word *Strain* will be used to denote the change of volume and figure constituting the deviation of a molecule of a solid from that condition which it preserves when free from the action of external forces; and the word *Stress* will be used to denote the force, or combination of forces, which such a molecule exerts in tending to recover its free condition, and which, for a state of equilibrium, is equal and opposite to the combination of external forces applied to it."

Again, in his "Applied Mechanics" (1860), we find, in § 86: "*Stress, its Nature and Intensity.*—The word STRESS has been adopted as a general term to comprehend various forces which are exerted between contiguous bodies, or parts of bodies, and which are distributed over the surface of contact of the masses between which they act. The INTENSITY of a stress is its amount in units of force, divided by the extent of the surface over which it acts, in units of area."

Then, in § 87, Rankine classifies three kinds of stress, (1) *Thrust or Pressure* (2) *Pull or Tension*, and (3) *Shear*, or *Tangential Stress.*

Further, in § 96: "*Internal Stress in General.*—If a body be conceived to be divided into two parts by an ideal plane traversing it in any direction, the force exerted between those two parts at the plane of division is an *internal stress.*"

Clerk Maxwell, in "Matter and Motion," Art. 37, says: "The mutual action between two portions of matter receives different names according to the aspect under which it is studied, and this aspect depends on the extent of the material system which forms the subject of our attention.

"If we take into account the whole phenomenon of the action between two portions of matter, we call it Stress. This stress, according to the mode in which it acts, may be described as Attraction, Repulsion, Tension, Pressure, Shearing Stress, Torsion, &c."

Again, in Art. 101.—"Stress.

"The next step in the science of force is that in which we pass from the consideration of a force as acting on a body, to that of its being one aspect of that mutual action between two bodies, which is called by Newton Action and Reaction, and which is now more briefly expressed by the single word Stress."

Thomson and Tait's "Natural Philosophy" (1867), Art. 658 (referring to the theory of elastic solids). ". . . the forces called into play through the interior of a solid when brought into a condition of strain. We adopt, from Rankine, the term *stress* to designate such forces, as distinguished from strain defined to express the merely geometrical idea of a change of volume or figure."

Thomson (Kelvin) in the 9th edition of the "Encyclopædia Britannica," article "Elasticity": Mathematical Theory, Chap. i. "Def. A stress is an equilibrating application of force to a body."

Tait, in "Newton's Laws of Motion" (1899), Art. 45:

"A pair of equal and oppositely directed forces, acting in one line, is a particular case of what is now called a *Stress.* The stress along a stiff rod (necessarily the same across every transverse section) may be either a *Thrust* or a *Tension*, that along a string or chain can be a *Tension* only. [But the term stress, in its widest signification, means *any* system of equilibrating forces.]"

"In a fluid the stress at any point is generally what is called *Hydrostatic Pressure*, whose characteristic is that the stress is the same across a small given plane area. . . . In all these cases the stress is measured by the amount per unit area of the surface on which it is exerted."

Love, in "Theoretical Mechanics" (1897), Art. 122, defines the stress at a point A across a plane interface passing through A, as the force per unit area exerted across a small area whose centroid is A.

From the preceding quotations there would seem to be a double ambiguity in the present usage of the word *stress.*

Firstly, it may be used to denote the whole mutual action between two portions of matter, A and B, say, in which case it would be specified by stating the force or system of forces exerted either by A upon B, or by B upon A; or it may be used to denote the *force per unit area* exerted by A upon B. The latter is clearly less widely applicable (torsional stress, *e.g.*, cannot be reckoned per unit area), and corresponds to what Rankine calls *intensity of stress*, or what is by some teachers appropriately named *unital stress.*

Secondly, the term *stress* may be defined as in the "Elasticity" article in the Encyclopædia to be an "equilibrating application of forces," or, as by Maxwell, to be the complete phenomenon including the "Action and Reaction" of Newton's Third Law of Motion.

To my mind there can be no doubt as to the greater usefulness of the latter definition, even though the former may be more consistent with some of Rankine's statements on the subject. It will be noted that in my quotation from Prof. Tait's work there seems to be a vacillation between the two meanings (what is meant there by "stress across a transverse section," or "stress across a small plane area"?), though he explicitly adopts the former alternative; and in the paragraphs of "Thomson and Tait" immediately following that quoted above there seems to be a similar shifting of ground in applying the term, while Maxwell's use of the word is consistent with his clear definition. This in itself argues strongly for the Maxwellian use of the word. Besides, the "equilibrating application" definition would seem to leave us in the lurch when we wish to name the internal forces of bodies not in equilibrium. And all who have had much experience in teaching dynamics to beginners must appreciate the help which the word in its Maxwellian sense affords in getting the student to see the difference between reaction and equilibrant, and to stop asking one such conundrums as "If action and reaction are equal, why does a body move?" And of course it is precisely the beginner for whose benefit we should take the trouble to be consistent in the use of words.

Let me conclude by offering the following suggestions for what they are worth:—

(1) Let the word "stress" be defined and used as in Maxwell's "Matter and Motion."

(2) Let "unital stress" or "unital stress at a point across a plane" be used as defined in §122 of Love's "Theoretical Mechanics." R. F. MUIRHEAD.

Glasgow, June 4.

I HAVE to thank the Editor for his courtesy in allowing me to see Mr. Muirhead's interesting letter. I quite agree that the meaning attached to the word "stress" by eminent writers during the fifty years from the time of Rankine to the present day has varied. At the same time, I observe that the only two definitions of the "measure of stress" which are quoted are of recent date, and both state clearly that a stress is measured by the force per unit area, though I find this same definition in Thomson and Tait, 1867 edition, Art. 661, a few lines below the quotation given by Mr. Muirhead. I think, then, I may claim sufficient authority for my statement, "Strictly a stress is measured by the force applied per unit of area," and for the doubt which I expressed as to the desirability of introducing the word "stress" as practically synonymous with "force" in a discussion of Newton's second law of motion.

While I share Mr. Muirhead's regret at the limitation thus imposed on the meaning of a general term "stress" as indicating the mutual action between two bodies, I hardly think his suggestion to distinguish between "stress" and "unital stress" will meet the case. REVIEWER.

Hybrid Oochromy, with a Note on Xenia.

IN a note on "Telegony, Xenia and Hybrid Oology,"[1] which appeared in *Natural Science* (vol. xiv. p. 394, 1899), I introduced the last-mentioned term to denote a singular phenomenon

[1] At the request of the editor I have altered the term hybrid oology to hybrid *oochromy*, which I agree is in many ways better, except that it would seem to refer to the coloration of the egg to the exclusion of its microscopic structure.

said to have been observed in birds, viz., that when a hen is fertilised by a cock of another kind the resulting egg is contained in a shell tinted, more or less, like those laid by the cock's own breed. At the time, I must confess, I was rather inclined to doubt if it did really occur, or if it were not a simple reversion, or a mistake, when my attention was drawn still closer to the subject by a friend who had kindly offered to assist in obtaining, if it were possible, additional proofs of telegony by first crossing a canary hen with a greenfinch cock and then returning her to her own breed. This was done, and resulted in three eggs being laid to the greenfinch. Their shells were all tinted more like the eggshells of a greenfinch than those of a canary. Two of these eggs were afterwards found to be infertile. This showed that the alteration in the tint of the eggshell had nothing to do with the nature of the fertilising spermatozoon. But the occurrence of hybrid oochromy could not be said to have been proved, for there is very little difference in the tinting of the eggshells of a canary and greenfinch, and I do not know whether the canary was purely bred or not.

I was thus anxious to find out for certain whether or not such an occurrence was possible. I therefore obtained three black Minorca hens, which had come of stock that had been purely bred for the last twenty years. The Minorca breed is the oldest variety of the famous Spanish fowls, of which the origin seems older than the recollection of it ![1] These three Minorca hens I penned up alone for more than four weeks, during which time thirty-two eggs were laid, and the shells of all of the later ones were of a very pure white colour.

The reason I had kept them alone for so long a time was that I required eggs entirely free from the intervention of any cock, and the commonly accepted opinion of poultry fanciers seemed to be that a period of nearly three weeks was necessary for the complete extermination of spermatozoa. However, to prevent any mistake, at the end of this time three eggs were artificially incubated for a period of forty-eight hours at the Durham College of Science, and they proved quite infertile.

After having thus demonstrated that the Minorca egg is contained in a pure white shell, I introduced into their pen a buff cock of the Cochin China breed, a breed famous for the brown with which its eggshells are tinted. The second egg laid after its arrival in the pen was provided with a shell of a very decided brown tint, and among a dozen or more laid within the succeeding two or three weeks, the shells of several were of a faint brown tint.[2] I was, however, unable to observe any difference in the microscopic structure of the eggs, such as is described by Herr von Nathusius. (See "Dictionary of Birds," by A. Newton, p. 190.)

This remarkable case appears to me to be an almost incontestable proof that hybrid oochromy does, at times, occur, as the only other way for accounting for pure bred black Minorca hens laying brown tinted eggs would be that they were reverting to some brown-egg-laying ancestors, a very unlikely supposition when we remember the age of the breed.

The next question to answer is—How does hybrid oochromy take place? I feel quite convinced, both from my own observations and those with the above-mentioned canary, that the tint of the eggshell is not, and cannot be, affected by the nature of the fertilising spermatozoon, and so we must turn our attention to the spermatic fluid, the chemical properties of which, acting in conjunction with those of the products of the shell-gland, will probably be found to be sufficient to cause this change of tint.

Hybrid oochromy has, in company with a closely associated phenomenon in another kingdom (I refer to Xenia), often been referred to as a case that cannot be explained by the Weismannian theory of heredity, *i.e.* the continuity of the germ-plasm. If the above explanation (and I can suggest no other) of hybrid oochromy should be proved to be correct, it is easily seen to be merely a chemical change and wholly apart from the phenomena of fertilisation. In the same way I should think it is very possible that xenia might be found to be not unconnected with the conjunction of the male and female elements forming the endosperm. It doubtless will be shown before long whether or not these two attempted explanations be correct. They will, I hope, however, tend to lessen the opposition to the Weismannian theory by showing how a fact which, at first sight, appears absolutely antagonistic thereto is found to be in complete accordance with it. It also shows what a deep effect may be induced in living organisms by the interaction of the chemical products of their glands.

I must here take the opportunity of expressing my best thanks to the Durham College of Science, Newcastle-on-Tyne, for allowing me the ground, &c., on which to conduct the experiment.

G. P. BULMAN.
Newcastle-on-Tyne.

[1] "The Poultry Book," by Lewis Wright. Popular edition, p. 340.
[2] Since writing the above I have incubated two of these eggs and found them fertile. At first sight this would seem to contradict the explanation given, but although I hold that fertilisation is not necessary, it certainly may take place in some cases.

The Swimming Instinct.

I HAVE just tested the inherited powers of swimming in newly hatched pheasants. I find that when placed in tepid water, at the age of about thirty hours, they swim easily with well-co-ordinated leg-movements and show very little signs of distress.

C. LLOYD MORGAN.
University College, Bristol, June 24.

RECENT SCIENTIFIC WORK IN HOLLAND.

BEGINNING with that which is of most general importance, we draw attention to the recent work of Prof. Hugo de Vries, of Amsterdam. Prof. de Vries, who is well known as a botanist and biologist and whose name is familiar to those acquainted with the history of modern chemistry, has just published the first part of a book entitled "Die Mutationstheorie. Erster Band. Versuche und Beobachtungen über die Entstehung von Arten im Pflanzenreich" (Leipzig: Veit, 1901), containing, as the title indicates, the account of a series of observations on the formation of new species in plants. Starting from the fact, well known to florists, of the appearance of "single variations" in their flower-beds, de Vries has been trying to find wild flowers which would show the same phenomenon. Of the 100 species investigated only one appeared to possess the property which was looked for, the *Œnothera Lamarckiana*, originally from America, but at present growing wild in Holland. Now about ten years ago de Vries transferred specimens of this plant to the botanical gardens at Amsterdam, and up to date he has studied as many as 50,000 of its descendants.

Of these 50,000 about 49,200 were in no respect different from the original patriarchal *O. Lamarckiana*, showing no tendency towards gradual change in any special direction, but only the common small fluctuating "variations" as regards size and appearance on either side of a normal, in fact resembling in that respect other plants and animals which are left to themselves without being interfered with.

Quite otherwise the 800 other plants. None of these, although appearing spontaneously, could be said to be representatives of the species *Lamarckiana*, from which they were descended. De Vries arranges them in seven distinct species, viz. 1 of *O. gigas*, 56 of *O. albida*, 350 of *O. oblonga*, 32 of *O. rubrinervis*, 158 of *O. nanella*, 221 of *O. lata* and 8 of *O. scintillans*. Now comes the crucial question of the whole investigation. What right has de Vries to look upon the differences between these seven species and the original species as being of a different order from the variations between the specimens of each species, and what entitles him to call these differences *mutations* as opposed to variations? The answer is this: a representative of these new species produces descendants the majority of which unmistakably belong to the same species as itself. Not all the new species behave in the same way; as an instance, the only representative of *O. gigas* was isolated and made to fertilise itself. From it were obtained 450 plants, all of which, with only one exception, were *O. gigas*, the one exception not being a return to *Lamarckiana* but belonging to a new variety. The plant is a strong one and retains its properties in subsequent generations so far as investigated.

The *O. albida*, on the other hand, which appeared frequently, is a weak plant, not very fertile, but perfectly constant so far as it went.

The last species in the above list, the *Œnothera scintillans*, differs from the others in this respect, that it is extremely unstable, *i.e.* possesses the property of mutation to a high degree, a large proportion of its descendants belonging to other species, specially *O. oblonga* and *Lamarckiana* itself.

Want of space prevents us from going into further details. Enough has been said to show that de Vries has evidently made a momentous discovery. So far as his observations go, new species appear *suddenly* by *mutation*, never as the outcome of a progressive *variation*. With legitimate pride the author declares that he has been able for the first time to watch the formation and development of new species. The facts are so striking and convincing that an outsider like the reviewer cannot but feel that a new period in the theories of the origin of species and of evolution has been inaugurated.

As we saw, some of the new species which made their appearance did not seem to be inferior in stability to the mother-species; on the other hand, one of the species, the *O. lata*, only appeared as female plants without pollen, and the *O. albida* did not show the same vitality as the others and was evidently doomed to disappear again. The observations, therefore, do not support the idea that in the formation of new species Nature is carrying out a definite plan; on the contrary, it all looks like accident. A new species may be one strong and fertile enough to remain, and possibly, under favourable conditions, replace the mother-species, but it may just as well be a sickly kind without any chance in the struggle for existence. For the struggle for life between individuals de Vries substitutes the struggle for continued existence between species, the new species always appearing suddenly.

De Vries' views are thus directly opposed to the common form of the theory of evolution; not that the importance of the single variations had escaped attention altogether, but they were always lost sight of, and prime importance is generally attached to the selection through the ordinary variations. De Vries' experiments support the results arrived at by Scott and other palæontologists that there is no evidence in the successive strata of the earth of a gradual development of one species into another and that everything points at small but sudden transitions.

It can hardly be believed that the species which de Vries happened to come across can be the only living one possessing the property of mutation, and men of science may therefore look forward to a new period of extensive research on the lines of de Vries' work. One feels that new life has been infused into the problem, and that tangible facts are now available and experiments which will replace a good deal of rather empty theorising and hollow controversy between rival speculations.

Turning to physical research we naturally think, first of all, of the discovery made by Prof. Zeeman some years ago when still assistant at Leyden in Prof. Onnes' laboratory. This discovery of the influence of a magnetic field on the period and character of light radiated by a source in the field came just at the right time to bring the theory of ions or electrons into prominence, a theory the necessity of which had already appeared in many ways, and which had been worked out for the first time by H. A. Lorentz. In fact, without any calculation it is easily seen what influence a magnetic field must have on the light-vibrations, if these consist in the vibrations of charged particles. We have only to resolve the vibration of the electron in the direction of the field and at right-angles to it, and, again, the latter component into two circular vibrations of opposite directions, to see at once that the magnetic force must increase the centripetal acceleration in the one and diminish it in the other circle without affecting the third vibration; thus the ordinary doublet in the direction of the field, and the triplet in a direction at right-angles to it, both with their proper states of polarisation, may be directly inferred from the theory in its simplest form. The direction of the circular polarisation of the doublet shows the preponderance of the negative over the positive electrons in producing the phenomenon, and from the magnitude of the change in wave-length, *i.e.* the width of the doublet, the ratio of the charge of the electrons to their mass can be inferred.

It need not be here explained how these conclusions were confirmed by, and confirmed results obtained in the study of the conduction of electricity in gases, by J. J. Thomson and his pupils and others. Zeeman's phenomenon soon became public property, and has since been developed by many others as well as by Zeeman himself.

H. A. Lorentz, whose name is connected with Zeeman's discovery and its immediate explanation, published the first complete account of his electron-theory in 1892 in French, and a more complete version in 1895 in German ("Versuch einer Theorie der electrischen und optischen Erscheinungen in bewegten Körpern." Leyden: Brill). To this theory Lorentz was led by his discussion of aberration phenomena; there is, perhaps, no phenomenon which is so readily explained in elementary text-books but gives so much trouble when properly discussed as aberration.

Lorentz's researches led him to adopt Fresnel's theory, which assumes that the ether is at rest and that bodies move through it without disturbing it. This theory is in accordance with the negative results of Lodge's well-known attempts to put the ether in motion by spinning two heavy wheels close together in the same direction. Starting from this hypothesis and assuming that all electric phenomena—including light—in bodies are due to the presence, motion and vibration of electrons acting on each other through the ether, Lorentz developed a theory which leads to the proper Maxwell-equations for bodies at rest, and, moreover, explains the great majority of the experiments and phenomena relating to moving bodies—such as aberration, Doppler's principle and Fresnel's law for the velocity with which light is "dragged along" by a moving body through which it passes.

In order to account for the negative result of Michelson's aberration-experiment, Lorentz assumes, as was done independently by Fitzgerald, that a body moving through the ether diminishes in dimension in the direction in which it moves.

Particular interest attaches to a further development of the theory in the direction of an explanation of gravitation on electro-magnetic principles. In a paper published in 1900 Lorentz shows, first of all, that gravitation cannot be explained by assuming that bodies are constantly emitting electro-magnetic radiations of very short wave-length and high penetrating power, and that gravitation is due to the action of the ether in this disturbed condition on the electrons contained in bodies. Lorentz therefore proposes a different theory which is, in a way, an adaptation of Mosotti's theory of gravitation. Assuming that all bodies contain an equal number of positive and negative ions, it is clear that an explanation of gravitation by the mutual action of these ions, this action being, of course, transmitted by the ether with the velocity of light, can only succeed if it is assumed that in some way the condition of the field produced by a positive ion differs from that which is due to a negative ion; the action of the fields of the two kinds of ions on other ions is then supposed to be different, but in such a way that the action of a + field on a + or − ion is the same as that of a − field on a − or + ion respectively. Hence it follows that there will be no *electrical* action between two bodies containing ions, *i.e.* no tendency to separate the positive and negative ions, but a resultant action which constitutes what is observed as gravitation.

Lorentz then goes on to show the effect of the motion of attracting bodies in modifying the ordinary law of gravitation, and here he arrives at a remarkable result. The deviations from Newton's law depend on the ratios of the velocities of the bodies to the velocity of light, but only on the second power of these small ratios. Hereby he removes the grave difficulty first pointed out by Laplace against the assumption of a propagation of gravitation with a finite velocity, unless this velocity was millions of times greater than the velocity of light. By the peculiar way in which the condition of the ether is disturbed by a moving ion the effect of the motion on the apparent attraction is of a higher order of smallness, and, in fact, so small that no arguments can be drawn from astronomical data in their present degree of accuracy against the assumption. The latter result is independent of the special form which Lorentz gives to this theory, but holds for any electro-dynamical theory of gravitation on similar lines. Thus it looks as if there were no objection to applying this important unification to our physical theories. How Lorentz's work, some of it well known to every student of physics, is appreciated outside the narrow limits of his own country was shown not so many years ago when he received a call to the University of Munich to be Boltzmann's successor, an offer which he did not accept; and again in the end of last year, when physicists of all countries united in honouring him on his semi-jubilee as a doctor of physics. The *livre jubilaire* presented to him on that occasion contains some sixty contributions, about twenty of which are due to Dutch physicists, several to Lorentz's own pupils.

Not in the work of his pupils only do we trace Lorentz's hand; much of the work done by the Dutch physico-chemical school has been to a certain extent dependent upon his collaboration. In the book just mentioned we find this authoritatively declared by Bakhuis Roozeboom, the creator, we may say, of a new branch of physical chemistry, viz. the application of the phase-doctrine to all kinds of equilibrium. As one of the latest applications of this theory, we mention the attempted, and already partly successful, disentanglement of the iron-steel problem by le Chatelier, Roberts-Austen, von Jüptner, and Roozeboom himself (*Zeitschrift für physik. Chemie*). This application is instructive in showing how purely theoretical investigations may suddenly begin to bear upon highly practical problems and be applied for industrial purposes.

Roozeboom's pioneer work was carried out when still in the laboratory of the Leyden University. He is now at Amsterdam as van 't Hoff's successor. In his laboratory we find, working on independent lines, one of van 't Hoff's pupils, Dr. E. Cohen. Of the many investigations carried out by Dr. Cohen none is of more general interest than that on the enantiotropy of tin, partly carried out in conjunction with Dr. van Eyk. Tin—the white metal as we use it—has been known frequently, under the influence of intense cold, to change its condition completely by turning into a grey modification of lower specific gravity. This fact was known to the ancients, and the literature on the subject which the authors took the trouble to bring together forms quite a bulky collection. Nobody had succeeded so far in clearing up the chaos which surrounded the phenomenon and its explanation; this has now been done in the papers referred to. It appears that the change from white into grey tin is a reversible phenomenon, the transition temperature being 20° C.; this point was determined both with the dilatometer and electrically by the modern method of transition-cells. The transformation of white into grey tin goes on with increasing velocity the lower the temperature down to −50° C., after which it decreases rapidly. The existence of a maximum in the rate of transformation is in accordance with what occurs in the transformation of solids and liquids, *e.g.* the solidification of an undercooled liquid (Tammann). The velocity is increased (1) by the addition of a little grey tin at the beginning; (2) by the addition of pink-salt; (3) by exposing the tin to the low temperature for a long period, or by alternately cooling and warming it. Above 20° the grey tin is transformed into the white modification with very rapidly increasing speed the higher the temperature. Measurements have been made up to 40°.

From the above experiments it appears that the whole of our tin-world, except on a few exceptionally warm days, is in an unstable condition. Dr. Cohen is now trying to establish the existence of similar transition-points for other metals.

Van Bemmelen's recent work on absorption and the properties of jellies is looked upon both by chemists and by physiologists as fundamental. In his researches on jellies he has struck out a new line in making accurate determinations of the relation between the vapour pressure of the jelly and its composition. One of the several new points discovered in that manner is that jellies, when taken through cyclic transformation, show hysteresis-phenomena, a circumstance which would not occur if the equilibrium between the jelly substance and the water was of a purely thermodynamical character, in which case the phase-rule with its consequences would hold. The equilibrium in the jelly depends upon its history, which is in accordance with the hypothesis that capillary forces are at work. Van Bemmelen looks upon a jelly as a system of two phases—a solid mixture of the colloid and water, and, embedded in the interstices of this mixture, water. In some jellies this solid part shows remarkable sudden transformation into a modification of different composition, but there is no indication of the existence of hydrates. It will interest the reader to hear that Prof. Bemmelen, having recently reached the age of seventy, has become a "professor emeritus" of the Leyden University. In the light of his recent experimental work there is some humour in the Dutch law considering a man of seventy unfit for a professorship. Van Bemmelen is succeeded by Schreinemakers, who may be described as Roozeboom's *alter-ego* (I am speaking from a scientific point of view).

Each country has its own bread, its own type of boots, its own characteristic music—can the same be said with regard to contemporary science? Looking broadly at the nature of the scientific work which is undertaken in different countries, and the manner in which the work is carried out and put before the public, we observe differences which are the natural manifestations of national characteristics. At the same time, these differences are chiefly external, superficial. No science, not even any special branch of a science, is now the property of any one nation. What appears to direct the exertions of the men of science of a country along particular lines more than national character is the influence of the few eminent men which the country is fortunate enough to possess. This influence in a small country like Holland is obvious even to the casual observer.

The origin of the young Dutch school of chemists is no doubt to be traced to van 't Hoff. In the same way we might speak of a Dutch school of which van der Waals is the origin. Those who want to acquaint themselves with the work done recently in this branch of physics are referred to the new edition of van der Waals' book on the continuity of the liquid and gaseous conditions. (German. Leipzig: J. A. Barth, 1900.) It is unnecessary to say anything of the first volume, which is a reprint of the former edition, and a translation of which has been available for several years. The second volume which has been added to the book contains van der Waals' theories of mixtures of two substances in the liquid and gaseous conditions. First of all we find a reprint of van der Waals's paper of 1890 in the *Archives Néerland-*

aires and the *Zeitschrift für physikalische Chemie*, and, secondly, later developments and additions and the application to recent experimental work, most of which was carried out by Prof. Kamerlingh Onnes and his pupils at Leyden. Van der Waals pays an eloquent tribute to Prof. Onnes' merits in this direction in the dedication of this second volume. It appears that but for him the original theory might never have been published and would certainly not have borne any fruit.

The importance of a theory of mixtures, as of other theories, lies in this, that it may show the connection between a number of phenomena which otherwise have to be treated separately, and may, directly or indirectly, bring to light new ones. That a theory was urgently wanted in the phenomena of mixtures even of two substances need not be set forth. In a theory of mixtures we may distinguish different parts, more or less independent of each other, which together form the whole. It consists firstly of an application of thermodynamics to find out the rules for the coexistence of phases—the gas and the one or two liquids. To do this it is only necessary to assume the experimental fact that the properties of mixtures form a continuous series between those of the components and, therefore, that a mixture has an equation of condition of the same general features as that of a single substance. Van der Waals is not the only man of science who has been working on these lines, although doubtlessly the first who conceived the notion of such a theory. Not only had special problems relating to mixtures been successfully treated by Konowaloff and others, but Duhem, applying his method of the thermodynamic potential, had been working in the same direction. In the reviewer's opinion, however, it cannot well be denied that the method used by van der Waals in attacking the problem by means of the "free energy" ψ, and its graphical representation, is by far the most effective and the safest guide amidst the intricacies of the problem.

Leaving alone questions of priority, we may say that the theory as sketched has led, more or less directly, to the complete disentanglement of the critical phenomena of mixtures, to the tracing of the proper features of the various diagrams between the pressure, volume, temperature and composition, and to the discovery of various other new facts, such as the existence of maxima and minima in the critical temperature and their connection with minima and maxima in the vapour pressure, and the influence of pressure on the coexistence of two liquids. All these and many other points are fully set forth by van der Waals in this second volume.

Van der Waals has not, however, contented himself with that; from molecular considerations he was able to deduce an equation of condition for mixtures of a definite form, depending, as does his well-known formula for single substances, on attraction-constants a and volume-constants b. It is somewhat to be regretted that in the original paper no attempt was made to guide the reader in ascertaining in how far special results arrived at were dependent upon this special equation or not; everybody will feel the importance of the distinction, and certain controversies which have arisen in connection with the theory would have been prevented by a clearer distinction on this head.

The importance of this point has increased lately in connection with the modern conception of normal (non-associating) and abnormal (associating) substances. Van der Waals' equation can be used for normal substances as an approximate guide, although even for these the approximation is very rough and hardly amounts to more than a certain resemblance, at least at small and medium volumes. For abnormal liquids the equation cannot even profess to do that, and van der Waals' results, in so far as they depend upon this equation, are not applicable to these substances at all. Lehfeldt has noticed that, so far as we know, normal liquids mix in all proportions and that partial miscibility occurs when at least one of the components is abnormal. Van der Waals' theory does not confirm this, inasmuch as such values may be assigned to the constants in his equation as will lead to partial miscibility. At the same time, as no normal liquids of partial miscibility have been discovered so far, this subject is outside the scope of van der Waals' equation.

The reader must not get the impression that results deduced for normal liquids by means of van der Waals' equation are of small value owing to the inaccuracy of the equation. An instance will illustrate this. Van der Waals discusses the question, also treated by Ostwald and others, what function of the composition of a mixture its vapour-pressure is. He arrives at certain conclusions, one of which is that there cannot be more than one maximum or minimum, at least that the combination of a maximum and a minimum is very unlikely. Guided by this result, Hartman (Leyden) has discovered that there is an obvious error in Konowaloff's result for propionic acid and water, the curve for this combination being in contradiction to Konowaloff's own measurements, and Kohnstamm, working in van der Waals' laboratory, similarly discovered an error in Linebarger's result for benzene and carbon tetrachloride, a result which, if it had been confirmed, would have been even more striking, as both these substances are normal. On the other hand, Caubet and Duhem maintain to have realised the double phenomenon in question with methyl chloride and sulphur dioxide; if the latter result were confirmed it would certainly show in a striking way with what extreme caution conclusions drawn from the approximate theory have to be accepted.

Owing to the recent establishment of a "van der Waals fund," the famous author is now in a position to conduct experimental researches in his own laboratory. Several valuable memoirs have already appeared under this trust.

A very interesting departure has been lately made by Kamerlingh Onnes and his pupils to construct plaster models of the ψ surface entirely based on experimental data. Models of that kind will no doubt become a powerful assistance in the understanding of the intricate phenomena displayed by mixtures.

Turning our attention towards the work which is being done in the Leyden laboratory, we notice researches which are being carried on relating to Hall's phenomenon, the magnetic rotation of the plane of polarisation and many others. A special feature of the work is the constant use of low temperatures down to the boiling point of air. We feel at a loss what particular part of the work to review specially; in the small space available no justice could be done to any one without being unjust to others, and we abstain from reviewing anything in particular, considering that the "Communications from the Physical Laboratory at Leiden" are widely distributed and will, no doubt, be sent to anybody interested who takes the trouble to apply for them.

Much else might have been mentioned in this review, but we have tried to select that which would find the largest number of interested readers. J. P. K.

MAXIME CORNU.

THE hand of death has been heavy on the French botanical world. In recent years it has fallen successively on Duchartre, Baillon, Naudin, de Vilmorin and Franchet: all men in the foremost rank, whom their fellow-workers in England counted as sympathetic friends. And now the untimely and unexpected death of Maxime Cornu has come upon many of us—and not least at Kew—as a personal grief. I saw him last autumn in Paris full of the business of congresses into which he was throwing himself with irrepressible vivacity and energy. He had often complained of ill health. But nothing in his appearance had ever suggested to me ground for serious anxiety. I had hoped to have induced him to pay us a visit this year. I could not go to his funeral; nothing remains but the sad satisfaction of writing these lines to his memory.

Cornu was born July 16, 1843, at Orléans. The ability which he displayed in his schooldays seemed at first likely to be absorbed by studies on the literary side. But under the influence of his father and of his distinguished brother, Alfred Cornu, he devoted himself to mathematics, and with considerable success. He published in the *Nouvelles Annales de Mathématiques* papers on geometrical subjects. In my judgment there could be no better preparation for a scientific career. Mathematics, as they are taught in France, habituate the mind to the grasp of general ideas and accustom it to rise from isolated facts to large generalisations. The descriptive side of science, it cannot be doubted, has a cramping influence, and it is the fate of too many of those who devote themselves to it to be unable "to see the wood for the trees." Cornu's mathematical studies, at any rate, decided him for a scientific career, and at the "École normale supérieure" he eventually fixed on botany. He was for a time assistant to Duchartre, professor at the Sorbonne, a man remarkable in many ways, but possessing in a more than ordinary degree the power of presenting with French lucidity the results of current research, not forgetting those of English workers. While with Duchartre, Cornu produced in 1873, as his doctoral thesis, his well-known memoir on the Saprolegniaceæ, to which the Academie des Sciences awarded the Desmazières prize. From the Sorbonne he moved to the Muséum as aide-naturaliste to Brongniart, whose daughter he afterwards married. Brongniart brought down to our own day the best traditions of that illustrious school of French botanists whose philosophic insight into the principles of plant morphology and taxonomy has probably never been rivalled, and certainly not surpassed.

Under Brongniart, Cornu devoted himself to mycology. He published in a comparatively brief period a profusion of papers, in which one is at a loss whether to admire most the untiring industry, the sagacity, or the wide range of his work. Everything pointed to his taking a foremost place in this branch of botany.

But no one can be a mycologist without being drawn into the study of plant diseases, in which fungi play so large a part. Vegetable pathology early attracted Cornu, and he did much excellent work in it. We owe to him the principle, now so familiar as to seem almost obvious, of preventive treatment by the careful destruction by burning of the *débris* of plants which may harbour resting-spores.

In 1868 a mysterious disease made its appearance amongst the vines in the South of France. Planchon, the professor of botany at Montpellier (who owed his early training to Kew), discovered the cause in an insect—*Phylloxera vastatrix*—introduced from the New World. The injury which this ultimately inflicted on the principal cultural industry of France has been compared, and probably with justice, to that of the most devastating of wars. That France has risen triumphant above this, as above so many other disasters, is but one example of the indomitable courage of its people. Cornu, from his official position and special qualifications, was necessarily at once absorbed in the task—hopeless as it seemed at first—of combating the scourge. For at least ten years, from 1872 onwards, he was occupied in little else. It is needless to enumerate the prominent position in various inquiries which he filled; the most important was that of "secrétaire de la commission académique du Phylloxera." His memoir on the whole subject published by the Academy has always seemed to me, for completeness and finish, a model of what such a research ought to be.

Cornu became the acknowledged authority on the subject of the Phylloxera. It had not been foreseen at first that the scourge, when once emancipated from its American home, might, and probably would, invade every wine-growing country. There were those who thought it impossible that it could cross the equator. The expectation was falsified and, in spite of all precautions, it made its appearance at the Cape. I advised the Cape Government to have recourse to Cornu, and his services were as generously given as, I know, they were warmly acknowledged.

In 1884 Cornu succeeded Decaisne as Professor of Culture at the Muséum—a position, if not so extensive in scope as that of the Director of Kew, scarcely less onerous. I had made Cornu's acquaintance some years before, and the circumstance of our similar official positions speedily brought us into closer intimacy. The position of an administrator under Government does not suit every temperament. The enthusiast must expect his ardour to be quenched with a good deal of official cold water. To Cornu, who had something of the engaging qualities of the *méridional*, this was hard to bear. My sympathy with him in his troubles, which were often not small, was certainly sincere, but I am afraid often seemed to him phlegmatic. In any case, the worries of administration pressed hardly on him and, notwithstanding the counsels of common friends, diverted him from the scientific work which we all expected of him, and which his really brilliant powers entitled us to expect.

At the moment that Cornu entered on his new duties, France had turned its attention anew to the field in which, in the past, it had done so much—colonial enterprise. Cornu's ambition—and it was a legitimate one—was to utilise the somewhat dormant resources of the Jardin des Plantes in the work, much on the lines of Kew. For my part it was more than a pleasure to give him all the assistance in my power. Agriculture is the great civilising agency. To reduce nomadic and predatory tribes to cultural pursuits is perhaps one of the most effective of missionary enterprises. Cornu threw himself into the work with little short of passion. What he accomplished, both for the French colonies and for the enrichment of the gardens of his own country, with resources more limited than we have at our disposal in England, is to me surprising. But, unhappily, at the moment when he had attained some measure of success his forces failed him, and he was not allowed to see his work fully crowned with accomplishment.

Cornu was the most loyal of Frenchmen. Had he been less so, he would not have sacrificed to the interests of France the career he might have devoted to science. I cannot but fear that while he lived the sacrifice he made was not fully appreciated. Many of us have wondered that a man who had done so much had never been admitted to the Institute. But that recognition could not have been long delayed, and this adds another regret to his untimely death.

W. T. THISELTON-DYER.

NOTES.

M. MAUPAS, of Algiers, has been elected a correspondant of the Section of Anatomy and Zoology of the Paris Academy of Sciences, in succession to the late M. Marion.

THE Harben medal of the Royal Institute of Public Health will be presented to Prof. Koch at a dinner to be held on July 24. Tickets may be obtained from the honorary secretary, Dr. W. A. Bond.

THE ethnographical collection of shamanistic implements, bead-work, musical instruments, &c., presented by Miss Owen to the Folklore Society, is on exhibition for a few days at the rooms of the Anthropological Society, 3 Hanover Square, W.

THE newly constituted "African Society," founded in memory of the late Miss Mary Kingsley, will hold its inaugural meeting at the United Service Institution, Whitehall, this afternoon, under the presidency of the Marquess of Ripon. This Society has been started with the object of studying the languages, laws and customs of the continent of Africa.

THE annual summer meeting of the Society of Public Analysts will be held at Cambridge on Friday, July 19.

PROF. RUDOLF VIRCHOW has been elected a knight, with the right to vote, of the Order Pour le Mérite for Sciences and Art.

AN official announcement has now been made in regard to the Rockefeller Institute for Medical Research, toward the establishment of which Mr. John D. Rockefeller has recently given 200,000 dollars. We learn from *Science* that the directors are Dr. William H. Welch, Baltimore, president; Dr. T. Mitchell Prudden, New York, vice-president; Dr. L. Emmett Holt, New York, secretary; Dr. C. A. Herter, New York, treasurer; Dr. Theobald Smith, Boston; Dr. Simon Flexner, Philadelphia; Dr. H. M. Biggs, New York. The purpose of the foundation, as the name implies, is to furnish facilities for original investigation, particularly in such problems in medicine and hygiene as have a practical bearing upon the prevention and treatment of disease. The sum of money mentioned above is not an endowment, but may be used for current expenses. The Institute will be situated in New York City. A building will not, however, be erected at present, but research will be conducted in existing laboratories under the auspices of the directors.

THE members of the Institution of Electrical Engineers who are participating in the visit to Germany have been heartily received at Berlin. On Monday they were entertained at dinner by the Berlin General Electric Company and by the firm of Siemens and Halske at the Berlin Fire Prevention Exhibition. Herr Geheimrath Rathenau, in welcoming the English guests, is reported by the *Times* to have said that electrical engineering, in which it would be admitted that Germany had made great progress, was "nothing else than the child of mechanical engineering, which Germans originally learned in England in the factories of London, Birmingham, Glasgow, &c." He thought they would admit that the English masters might well be proud of their German scholars.

IN the House of Commons on Monday Sir W. Hart Dyke asked the President of the Board of Agriculture if he intended to transfer the powers of his Board in respect of agricultural instruction to the Board of Education, he intended that the Board of Agriculture should undertake the organisation and coordination of such instruction throughout England and Wales. In reply, Mr. Hanbury said: "I am not prepared to transfer elsewhere any part of the existing duties of the Board of Agriculture, the functions of which, especially with regard to agricultural instruction, might, on the contrary, with advantage be enlarged. I am unable to state as yet in detail how this can be brought about, but I attach great importance to the necessity for extending the work already done by the Board in collating and publishing the results of experiments and the most recent discoveries bearing on agriculture, both in this country and abroad, and also to the advantage to be gained by friendly cooperation between the Board and county councils in devising the best methods of instruction and experiment."

THE movement to establish a Washington Memorial Institution for post-graduate study and research in Washington appears to have met with success. It originated in the Washington Academy of Sciences, and the organisation and scope have now been agreed upon. The primary aim is to facilitate the utilisation of the various scientific and other resources of the Government for purposes of research, thus cooperating with all universities, colleges and individuals in giving men and women the practical post-graduate training which cannot be obtained elsewhere in the United States and which is now available only to a limited degree in the city of Washington. An Act of Congress approving these principles was passed in March, and reads as follows:—"That facilities for study and research in the Government Departments, the Library of Congress, the National Museum, the Zoological Park, the Bureau of Ethnology, the Fish Commission, the Botanic Gardens, and similar institutions hereafter established shall be afforded to scientific investigators and to duly qualified individuals, students, and graduates of institutions of learning in the several States and Territories, as well as in the District of Columbia, under such rules and restrictions as the heads of the Departments and Bureaus may prescribe." The organisation is independent of Government control, and the management is vested in a board of fifteen trustees and an advisory committee composed chiefly of the heads of Government Departments. *Science* states that the new institution will attain substantially the objects desired by the advocates of a National University, without being subject to the objectionable features of a university sustained by the Government in competition with the existing universities.

THE Council of the Society of Arts have awarded the Society's silver medal to the following readers of papers during the session of 1900–1901:—Major Ronald Ross, F.R.S., for his paper on "Malaria and Mosquitoes;" Dr. W. Schlich, F.R.S., for "The Outlook for the World's Timber Supply;" Lieutenant A. T. Dawson, late R.N., for "Modern Artillery;" Mr. Fritz B. Behr, for "The Proposed High-Speed Electrical 'Monorail' between Liverpool and Manchester;" Mr. Percy R. Macquoid, for "Evolution of Form in English Silver Plate;" Prof. Raphael Meldola, F.R.S., for "The Synthesis of Indigo;" Sir Joshua Fitch, for "School Work in Relation to Business;" Mr. Marconi, for "Syntonic Wireless Telegraphy;" Mr. Henry John Tozer, for "The Growth and Trend of Indian Trade—a Forty Years' Survey;" Colonel Sir T. H. Holdich, K.C.I.E., for "The Greek Retreat from India;" Mr. J. D. Rees, for "Madras, the Southern Satrapy;" the Hon. Sir J. A. Cockburn, K.C.M.G., for "The Commonwealth of Australia;" Lieutenant Carlyon W. Bellairs, R.N., for "The Coal Problem: its Relations to the Empire;" Mr. William Burton, for "Recent Advances in Pottery Decoration;" and Mr. Hugh Stannus, for "Some Examples of Romanesque Architecture in North Italy."

AMATEUR photographers visiting London, and desiring to obtain pictures of interesting sights and objects, will find of service a leaflet prepared by Messrs. Sanders and Crowhurst and Mr. R. W. Paul. A list is given of suitable subjects, arranged in six groups, each group being sufficient for a day's work.

A MEETING of the Physical Society will be held on Friday, June 28, in the Wheatstone Laboratory, King's College, Strand, by invitation of Prof. Adams. Papers will be read on the effect of a high-frequency oscillatory field on electrical resistance, by Mr. S. A. F. White; and on the spectrum of cyanogen, by Mr. E. C. C. Baly and Dr. H. W. Syers.

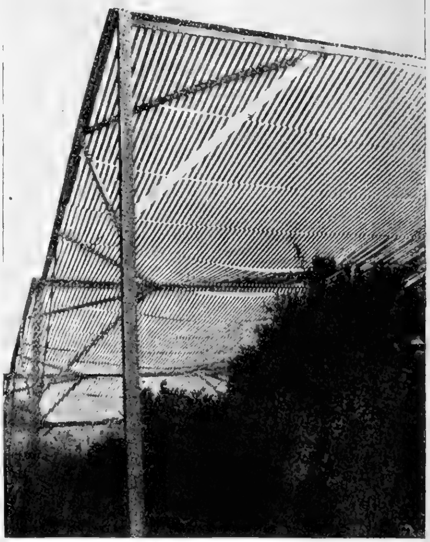
AN interesting incident is recorded in the *Engineer* (June 14). A petrol motor car returning from Biarritz to Paris came to a standstill near Etampes for want of petrol, and as another supply could not be obtained in the neighbourhood the driver resolved to try the only spirit obtainable—namely absinthe. He charged his car tanks accordingly, and afterwards declared that "the motor never ran better than with this improvised fuel."

PARTICULARS of the ethnographical survey undertaken by the Government of India in connection with the census, as suggested by the British Association, are given in the Allahabad *Pioneer Mail*. The following is a summary of the scheme prepared by the Government and sanctioned by the Secretary of State:—Local Governments will select from among their officers a superintendent of ethnography, who will undertake to carry on the inquiries proposed, in addition to his ordinary duties. The superintendent will correspond with the district officers with the object of ascertaining what persons in their districts are acquainted with the customs, traditions, &c., of particular tribes and castes. The information thus obtained will be collated by the superintendent, and will be supplemented by his own inquiries from such representative men as he can find, and by researches into the considerable mass of information in official reports, in the journals of learned societies and various books. The superintendent will work up all this material into a ystematic account of the tribes and castes of the province somewhat in the form adopted in "The Tribes and Castes of Bengal," and that followed by Mr. Crooke for the North-Western Provinces and Oudh. By working on these lines the Government of India believe it will be possible to get a fairly complete account of the ethnography of the larger provinces drawn up within four or five years. It is estimated that the survey will cost 10,000*l.*, excluding the cost of printing the results, which cannot be calculated at present. The Secretary of State has accorded his sanction to an expenditure not exceeding this amount. It is also proposed to collect physical measurements of selected castes and tribes. In Madras the work will be done by Mr. Thurston, superintendent, Central Museum, whose ethnographic researches in the south of India are well known, and who, it is understood, is likely to be selected by the Provincial Government as superintendent of ethnography for the Madras Presidency. The general direction of the scheme will be entrusted to Mr. Risley, whose official title will be for this purpose Director of Ethnography for India. The Governor-General in Council trusts that on this, as on former occasions, ethnologists and scientific societies in England and America will assist the Director with their advice, will refer to him points which they may wish to be made the subject of inquiry in India, and will, if possible, supply him with copies of publications bearing on the researches now about to be undertaken.

AMONG the many useful publications issued annually by the Royal Observatory of Belgium we draw special attention to "Éphémérides météorologiques et naturelles." The work is an excerpt from the "Annuaire météorologique" for 1901, and contains the monthly and annual values of the principal meteorological elements and phenological observations for Brussels (or Uccle) for each year from 1833 to 1900. Similar information relating to the wind has been published in a separate work. We extract the following interesting items from this long and valuable series of observations. The absolute maximum shade temperature was 95°·4 F. and the minimum 4°·4. The average annual rainfall amounts to 28·56 inches and the mean number of rainy days is 190. The relative humidity at noon is fairly uniform, varying in the yearly average from a minimum of 67·6 to a maximum of 79·9 per cent.

IN the *Bulletin* of the Cracow Academy M. S. Zaremba discusses the proof of the existence, for any given connected region bounded by a surface S, of a series of functions analogous to spherical functions and satisfying the well-known physical equation $(\nabla^2 + k^2)V = 0$. The fact that such functions exist was discovered by Poincaré, and demonstrated by Le Roy for surfaces satisfying certain conditions. Stekloff has studied the same problem from a different point of view, but the methods of Le Roy and Stekloff depend on certain transformations of the surface for which the existence of so-called fundamental functions has to be proved. M. Zaremba now claims, without employing any transformation, to have proved the existence of fundamental functions for any surface satisfying certain stated conditions, such as, for example, that the tangent plane at every point is unique. The series of functions has not been proved to be infinite in number, but this gap in the proof the author considers can be easily filled.

SYSTEMATIC efforts are made in California to reduce injury to fruits by frost. Mr. A. G. McAdie describes some of the means used in the U.S. *Monthly Weather Review* for February, and the accompanying illustration is one of several which illustrate his paper. This represents an elaborate structure of lath-screens in use upon one fruit ranch. The lath covering may be considered as forming a well-ventilated hot-house, and there is



Screen or protecting fruit from frost.

no question as to its protective value, but the expense of erecting it will prevent its wide adoption. An investigation of the conditions producing frost has shown that frost is primarily a problem in air drainage. Mr. McAdie states the principle that "wherever the air was stagnant the injury from frost was most marked; and conversely, wherever the air was in motion, there was little damage from frost." In California, much of the damage appears to be done by the sudden warming of the chilled fruit at sunrise. If a screen is interposed between the fruit and the sun, so that the warming is gradual, the fruit is saved from injury.

"SUNNY DAYS AT HASTINGS AND ST. LEONARDS" is the title of a well-illustrated and well-printed little handbook for south-east Sussex, by Messrs. W. H. Sanders and P. Row. There is a "six-inch" map of Hastings and St. Leonards, and another map, on the scale of an inch to four miles, of the country as far as Seaford, Tunbridge Wells and Ashford—all for the price of

6*d.*, being vol. xvi. of the handbooks published under the auspices of the "Homeland Association for the Encouragement of Touring in Great Britain and Ireland." Apart from the descriptions of places of historic interest, including many famous old castles, it is interesting to find chapters on the geology of the district and on the prehistoric people of Hastings, by Mr. W. J. Lewis Abbott. The great physical changes recorded in the rocks are briefly pictured, though with few local descriptions, and then Mr. Abbott (whose enthusiastic labours in this field are well known) tells of the works of man in Plateaulithic, Palæolithic and later ages, concerning which abundant material has been obtained in Sussex and other parts of the south-east of England. A good account is also given of the various objects of interest in the Hastings and St. Leonards Museum.

FROM the Report of the Australian Museum for 1899 we learn that Mr. A. J. North's "Catalogue of the Nests and Eggs of Birds found breeding in Australia" is making satisfactory progress. The work, which is to include thirty plates of eggs and forty of nests, will be expensive, so that its cost is to be spread over several years. Apart from a complaint as to lack of funds, the general progress of the Museum seems to be satisfactory.

TWO interesting papers on wild life in Australia appear in the May number of the *Victorian Naturalist*, the one, by Mr. D. le Souef, being entitled "Among the Waterfowl in Riverina," and the other, by Mr. C. French, "A Naturalist on the Mallee." In the latter reference is made to the appearance of a swarm of caterpillars of the "army worm," which caused incalculable damage to the "wallaby grass." The caterpillars were, however, attacked in turn by a fungus (*Entromophthora australis*), which probably made a clean sweep of the entire horde.

THE latest issue of the *Zeitschrift für wissenschaftliche Zoologie*, which completes vol. lxix., is mainly devoted to morphological subjects, although it includes a description of a new genus (Ludwigia) of holothurian from New Zealand, represented by a species described in 1897 as *Colochirus ocnoides*. The morphological subjects comprise the development of the rook, the nature of the reproductive organs of the Ctenophora, the development of the vertebral column of the rat, the structure of the gills of fishes, and the difference between the female reproductive organs in the gnats and mosquitoes of the genera Culex and Anopheles.

To the June number of the *Zoologist* Mr. W. W. Fowler communicates an interesting article on the winter singing of the thrush. Owing to the mildness of last November thrushes "were unusually numerous, and almost every individual seemed to be uttering some kind of song, and continuing it more or less from early morning, when the voicefulness was at its highest point, till sunset, and even later." The author set himself the task of determining whether this unusual outburst of song was due merely to the birds being in good condition, or whether it had any connection with the ensuing pairing-season. Despite a complete cessation between January 3 and 21, he inclines to think "that the great outbreak of song in the autumn was, in the case of mature birds at least, a forecast of the coming breeding-season."

THE most striking feature in the Report of the Field Columbian Museum at Chicago for the year 1899-1900 is formed by the full-page illustrations of groups of mammals mounted amid their natural surroundings. By far the best of these represents a party of five Somali hartebeests in the Haud desert, the attitudes of the animals being absolutely life-like. There is nothing to approach this grouping in our own national museum. The lectures delivered from time to time in the museum appear to attract good audiences. Two courses, one of eight and the other of nine lectures, were delivered during the period in question. They comprised anthropological, zoological and economic subjects. The total expenditure of the museum during the year was a little more than 24,000*l.*

WE have received a pamphlet indicating the contents of a bibliography and subject-index of the Schizomycetes (Bacteria) now appearing in the "Scientific Roll." It is stated to show the scope and extent of the work in January 1901, but is subject to alteration. The method of cataloguing seems to be to divide the subject into a number of groups—general, diseases, micro-organisms, &c.—each of which is again subdivided, and the subdivisions have appended to them the years in which papers on their subject-matter have appeared. In the second half of the work the matter is divided into years, and under each year an alphabetical list of authors is given, with the titles of their papers. The method of arrangement would have been rendered far clearer had a few specimen pages been included. The few references we have checked we have found to be accurately given. Judging from the list of contents there are overlappings and omissions. For example, "Bacillus of mouse typhoid" and "Bacillus typhi murium," "Bacillus of Plague" and "Bacillus pestis" are given as separate headings with different references, while "Micrococcus Melitensis" and "Bacillus pseudotuberculosis" seem to be omitted. The work may be, and might be made, a very valuable one, but details are wanting to enable a correct estimate as to its value being formed. For example, there is no indication whatever as to the journals, &c., that are to be indexed; a list of these should be given.

MR. BERNARD QUARITCH has issued a catalogue of the valuable entomological library collected by the late Mr. J. H. Leech, together with other important works on natural history and botany offered for sale at his establishment in Piccadilly.

MESSRS. DULAU AND CO. announce for publication in July a "Flora of Guernsey and the Lesser Channel Islands," by Mr. Ernest D. Marquand. The work will comprise classified lists, with full details of local distribution, of the flowering plants, ferns, fern-allies, characeæ, mosses, hepaticæ, fungi, lichens, sea-weeds, freshwater algæ, and diatomaceæ which have been found in Guernsey, Alderney, Sark, Herm, Jethou, Lithou, Crevichon and Burhou. Each island is treated as a separate and independent botanical area, possessing its own peculiar features. It is stated that upwards of 2500 different species are recorded for Guernsey alone.

THE syndics of the Cambridge University Press have undertaken the publication of the first part of the "Index Animalium," to the preparation of which Mr. C. Davies Sherborn has devoted so many years. The object of the index is to provide zoologists with a complete list of all generic and specific names given by authors to animals both recent and fossil since January 1, 1758, the date of the tenth edition of Linnæus' "Systema Naturæ." With each name will be given an exact date and a reference intelligible to the layman as well as to the specialist. The British Association appointed a special committee to watch over the inception and progress of the work, the preparation of which was undertaken in 1890. Financial support has been given by the British Association, the Royal Society and the Zoological Society, while the authorities of the British Museum have afforded continual assistance. The portion of the work already completed and in the press covers the period from 1758–1800 and consists of 61,600 entries.

WE have received from Messrs. Müller, Orme and Co. a specimen apparatus, designed by Mr. C. T. Tyrer, for use in making the Marsh-Berzelius test for arsenic. Commonly the flask in which the hydrogen or the arseniuretted hydrogen is generated is closed either with an ordinary cork or with an india-rubber stopper, and, with the object of arresting seleniuretted and sulphuretted hydrogen, the gas, as it passes from the flask to the mirror-tube, is brought in contact with lead acetate solution, sometimes bubbled through the liquid and sometimes passed through cotton-wool or over a roll of filter-paper saturated with the solution. Where cork has been in contact with arseniuretted hydrogen there is danger of sufficient of the arsenic compound being retained by this porous substance to render its continued use a possible source of error; with rubber there is always the chance that arsenic or antimony may be present as one of the constituents of the material, and as regards the use of lead acetate it has been urged that to bubble the gas through a small quantity of the solution is safer than to pass it through or over cotton-wool or filter-paper. The apparatus sent us has been designed to avoid the use of a cork or rubber stopper, and to include a convenient means of passing the gas through a minimum quantity of lead acetate solution. To a wide-necked flask of 200 c.c. capacity is fitted a hollow glass stopper, perforated by the gas-exit tube, which supports a bulb containing a small quantity of 10 per cent. acetate of lead solution. The stopper is ground to fit tightly into the neck of the flask, and as the gas passes up the exit-tube it bubbles through the lead acetate solution in the bulb and so on to a calcium chloride drying-tube, to which is attached the mirror-tube in which the arseniuretted hydrogen is decomposed. The apparatus is neat and effective.

THE additions to the Zoological Society's Gardens during the past week include three Derbian Wallabys (*Macropus derbianus*, ♂ ♀ and juv.) from Australia, presented by Captain Ben Jones; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. Thomas Mackenzie; an Egyptian Jerboa (*Dipus aegyptius*) from North Africa, presented by Mr. J. Manuel; an Active Amazon (*Chrysotis agilis*) from Jamaica, presented by Mrs. V. A. Taylor; a Darwin's Rhea (*Rhea darwini*) from Patagonia, presented by Mr. H. F. Fox; a Large-billed Weaver-Bird (*Ploceus megarhynchus*, ♂) from Naini Tal, deposited; a Baya Weaver-Bird (*Ploceus baya*, ♂), two Black-throated Weaver-Birds (*Ploceus atrigularis*), a Black-headed Finch (*Munia malacca*), a Chestnut-bellied Finch (*Munia rubro-nigra*), two Hybrid Finches (between *Munia malacca* and *M. rubro-nigra*) from India, presented by Mr. Frank Finn; two Bennett's Wallabys (*Macropus bennetti*) from Tasmania, a Black Wallaby (*Macropus ualabatus*) from New South Wales, a Ring-necked Parrakeet (*Palaeornis torquata*) from India, an August Amazon (*Chrysotis augusta*) from Dominica, fourteen Algerian Skinks (*Eumeces algeriensis*) from North-west Africa, a Derbian Sternothere (*Sternothaerus derbianus*) from West Africa, three Simony's Lizards (*Lacerta simonyi*) from the Canaries, eight Three-streaked Skinks (*Mabuia trivittata*), two Streaked Skinks (*Mabuia vittata*), a Hissing Sand Snake (*Psammophis sibilans*) from Syria, four Grey Monitors (*Varanus griseus*), five Common Skinks (*Scincus officinalis*), four Ocellated Sand Skinks (*Chalcides ocellatus*), six Turkish Geckos (*Hemidactylus mabouia*) from Western Asia, deposited; an Axis Deer (*Cervus axis*, ♂) from India, purchased; six Silver Pheasants (*Euplocamus nycthemerus*), four Gold Pheasants (*Thaumalea picta*), six Common Pheasants (*Phasianus colchicus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JULY.

July 1. 9h. Jupiter in conjunction with moon. Jupiter 3° 42′ S.
1. 19h. Saturn in conjunction with moon. Saturn 3° 36′ S.
2. 9h. 29m. to 9h. 47m. Moon occults B.A.C. 6710 (mag. 6·0).
3. 11h. 2m. to 14h. 6m. Transit of Jupiter's Sat. III.
5. 9h. Saturn in opposition to the sun.
15. Venus. Illuminated portion of disc = 0·936, of Mars = 0·900.
17. 10h. 34m. Minimum of Algol (β Persei).
22. 10h. 59m. Moon in conjunction with α Virginis (Spica).
24. Saturn. Outer minor axis of outer ring = 18″·08.
28. 9h. 51m. to 11h. 6m. Moon occults 21 Sagittarii (mag. 4·9).
28. 11h. Jupiter in conjunction with moon. Jupiter 3° 37′ S.
29. 0h. Saturn in conjunction with moon. Saturn 3° 34′ S.
29. 8h. 33m. to 9h. 48m. Moon occults *d* Sagittarii (mag. 4·9).

BLACK SPOT ON JUPITER.—On June 2, Sig. J. Comas Sola, working at the observatory of Barcelona with a six-inch Grubb equatorial (power 200), noticed a strange marking on System II. of the planet's belts. From the time at which it passed the central meridian on that day its longitude would appear to be about $\lambda = 73°·1$; its latitude would be about 15°.

The tone of the spot is almost black, with a light garnet tinge, and might without close attention be mistaken for the shadow of a satellite. It is very sharp and circular, but on careful examination a very pale penumbra is seen before and behind the spot itself, the posterior penumbra being the more prominent of the two.

No signs of this spot were apparent on May 31.

TEN-YEAR GREENWICH STAR CATALOGUE FOR 1890.—The second ten-year star catalogue recently issued from the Royal Observatory forms Appendix II. to the *Greenwich Observations* for 1898, and contains the reduced places of 6892 stars for the epoch 1890·0, from observations made with the transit circle during the period 1887–1896.

The various corrections investigated are described at length, one interesting point brought out being that the observations from 1895–1899 show a diurnal change in the position of the nadir, the observations taken about noon and midnight giving positive corrections to the observations made near the time of sunset.

Comparisons are also given with the data of other standard catalogues, from some of which the proper motions of 174 stars are deduced.

NEW NEBULÆ.—In the *Comptes rendus* (vol. cxxxii. pp. 1465–1467) M. Bigourdan gives a descriptive table of twenty-one new nebulæ discovered with the north-west equatorial of the Paris Observatory, bringing up the number found in this way to 392.

PARALLAX OF μ CASSIOPEIÆ.—The eighteenth volume of "Contributions from the Observatory of Columbia University" contains an investigation of the parallax of μ Cassiopeia, made by Mr. G. N. Baur from the Rutherfurd photographic measures of twenty-eight plates of the region taken during 1870–1873.

The final value determined for the parallax is

$$\pi = 0''·238 \pm 0·014.$$

A table is also included showing the positions of fifty-six of the neighbouring stars used in the determination.

NEGATIVE AFTER-IMAGES AND COLOUR-VISION.

FOUR years ago I described an apparatus by which apparent transformations of colour could be produced (*Proc. Roy. Soc.*, vol. lxi. p. 268; NATURE, vol. lvi. p. 128). The essential part of it is a disc, partly black and partly white, having an open sector at the junction of the black and white portions, as shown in Fig. 1. If such a disc is caused to turn five or six times in a second while its surface is strongly illuminated, a coloured object placed behind it and viewed intermittently through the opening generally appears to assume an entirely different hue, more or less approximately complementary to the true colour of the object. A piece of red ribbon, for example, is seen as bluish-green and a green one as pink. The effect is due to the formation of negative after-images upon the white portion of the disc.

A number of observations made with this apparatus showed that the "pulsative after-images," as they may be called, differed in several important respects from the ordinary negative after-images seen upon a white ground after the gaze has been fixed for some time upon a coloured object. Among other things, they often appeared much more intense or saturated, which for obvious reasons was rather surprising. And again, it was found that the colours of the pulsative and of the ordinary after-images were sometimes very different. The pulsative after-images of red, of purple and of orange, for instance, were all of nearly the same bluish-green tint, and those of yellow and of blue were generally pink, showing considerable variations from the true complements. These and other anomalies led me to make some experiments with spectrum colours, which could be blended into uniform mixtures of known composition, instead

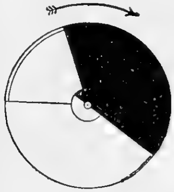


FIG. 1.

of with pigments, the apparatus employed for the purpose being a simple form of Sir Wm. Abney's well-known "colour-patch" apparatus. The experiments, of which a short account is here given, are fully described in a paper recently communicated to the Royal Society (*Proc. Roy. Soc.*, May 23).

A short pure spectrum, some three or four inches long, is projected, by means of a spectroscope collimator, a prism and an achromatic lens, upon an arrangement known as a "slit-screen." This consists of a wooden board having an oblong window over which slide three brass slit-frames carrying adjustable slits. The two outer slit-frames are attached to sliding shutters, which serve to cover such portions of the window right and left of the slit-frames as would otherwise be open to the light; the spaces between the middle slit-frame and the two outer ones are closed by opaque black ribbons, constituting miniature spring-roller blinds. Each slit-frame can be moved independently to any desired position and clamped by a set-screw. When it is necessary to use larger portions of the spectrum than can be transmitted by the slits, the slit-frames and their appurtenances are removed from the screen and the spectrum is dealt with by means of one or more thin metal plates, which are inserted into a second pair of guides fixed on the other side of the screen. Each of these guides has three parallel saw-cut grooves in it, so that plates sliding in different pairs of grooves may be made to overlap one another, and thus screens or openings of almost any desired width may be provided with very little trouble. The selected portions of the spectrum pass through the slits to a large lens, which projects upon a white screen the image of a circular aperture in a diaphragm placed just in front of the prism. This image, which is $1\frac{1}{2}$ or 2 cm. in diameter, constitutes the colour-patch; it is illuminated by a uniform mixture of the spectrum-rays transmitted by the slit-screen. When the wave-lengths of the light are to be determined a screen of ground glass is put in the place of the opaque white screen and the slit of a spectroscope is brought near the bright image on the glass. To produce a bright ground upon which to see the after-images a beam of white light, derived from the same electric arc as the spectrum, is directed upon the screen. The white light passes through the aperture of an iris-diaphragm, and a lens is placed to project an image of the aperture upon the screen. The "white-light disc" so formed is concentric with the colour-patch, and in most cases of slightly greater diameter.

In the path of the two beams of light illuminating the colour-patch and the white-light disc is placed a zinc disc having two apertures, one near the centre to admit the spectrum-rays, the other near the circumference to admit the white light. This is caused to turn about five times in a second, and the apertures are so arranged that the sequence of phenomena produced upon the screen may be as follows:—The colour-patch is projected for about 1/40 second, then it is extinguished and immediately succeeded by the white-light disc; this remains for 3/40 second, and is followed by an interval of darkness lasting 1/10 second, after which the colour-patch reappears and the cycle begins again. The appearance presented to the eye when the true colour of the patch is green is that of a purple disc surrounded by an annulus of flickering white. Other colours, of course, produce pulsative images of different hues. It is sometimes better to view the pulsative image directly by means of an eye-piece instead of receiving it upon a screen; two or three methods by which this can be effected are described in the paper.

Perhaps the most interesting of the various effects observed with this apparatus is one which appears to throw some light upon the origin of the pulsative image and to show why the true colour is so completely lost. It was noticed that when the white-light disc was made a little smaller than the colour-patch, the pulsative image, which was in this case of the same size as the white-light disc, was surrounded by a dark ring. This observation led me to make what is called in the paper the "black spot" experiment. A circular piece of tinfoil was gummed to a glass plate which was placed behind the iris-diaphragm, a sharply defined black spot being thus formed in the middle of the white-light disc, as indicated in Fig. 2, where the outer circle represents the white-light disc, the shaded circle the colour-patch, and the inner one the black spot upon the white-light disc. The diameter of the black spot was made, after several trials, 0·6 cm., or rather more than one-third of the diameter of the colour-patch. Suppose the colour-patch to be green. When the apparatus is worked, the patch becomes purple; the site of the black spot, being strongly illuminated five or six times in a second by green light, might be expected to appear green; but it remains perfectly black; no trace of a flicker of green light can be seen upon it. This induced blindness is most conspicuous when the light is green or yellow; it does not occur at all with extreme red or with violet light; nor does it generally occur if the luminosity of the colour-patch is reduced below a certain limit, that of the white-light disc remaining constant. A colour of feeble luminosity can be seen upon the black spot, while a brighter cannot, which is a paradox; and it was noticed that as soon as the spot became distinctly coloured, the pulsative image almost disappeared. Absence of colour from the black spot is essential for a good pulsative image.

It is clear that we have here an example of what I have called in other papers a border effect; in certain cases light has the power of exciting some action just outside the boundary of the image projected upon the retina. The black spot is, of course, merely a device for exhibiting in a convenient manner a border

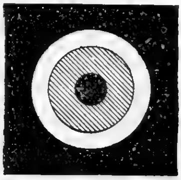


FIG. 2.

effect which extends for about half a degree beyond the white light impression. The experiment proves conclusively that, under the given conditions, white light has the power of restraining the visual sense-organs adjacent to those upon which the white light actually falls from responding to the green stimulus. This is of importance as indicating what occurs within the area illuminated by white light, for it would seem to follow *a fortiori* that the sense-organs which are directly acted upon by the white light must be similarly incapacitated from evoking any green sensation. In the formation of the pulsative image, then, it is not the fact, as generally believed, that the green sensation is produced for a moment and then swamped by a more powerful white one so completely as to escape notice; it actually never comes into existence at all. Nevertheless, the effects of fatigue by green are exhibited, and the physically white ground is seen as purple.

Only one possible explanation of the phenomenon has yet occurred to me. The facts can be accounted for in a perfectly simple manner if we suppose, as postulated by the theory of Hering, that there is an independent white sensation, and, further, that the latent period for a colour sensation is very much greater than that for white. For green, under the conditions of my experiments, the latent period would be at least 1/40 second, while for white it can hardly exceed 1/500 second, though the luminosity of the two may be as nearly as possible equal. The latent period for red is probably not very different from that for green under similar circumstances, while that for blue is considerably greater.

If in a darkened room a ray of green light is admitted to the eye for 1/40 second, one sees a flash of green; but, assuming that the suppositions which have been put forward are correct, the visible flash is not contemporaneous with the physical illumination. One does not begin to experience the green sensation until after the green ray which excited it has been shut off. What is actually perceived is, in fact, a positive after-image, the duration of which may be considerably longer than that of the stimulus. But if a sufficiently luminous white surface is presented to the eye immediately upon the expiration of the brief period of stimulation by green light, the after-image formed will not be positive, but negative, and the only colour perceived will be purple. The fatigue to which the negative image is due must have been set up during the latent period, when no image at all was actually perceived.

The formation of vivid pulsative images depends not only upon the latent period, but also upon persistence, luminosity, the duration of the primary impression and of the periods of light and darkness, and upon other circumstances. And the conditions which are best for some colours are not so for others. This fact obviously suggests that the pulsative image might afford a means of analysing compound colour-sensations, though so far it has been found available only to a limited extent. If the complete spectrum is projected upon the screen, it is seen at once that the blue-green pulsative image of the red, and the purple pulsative image of the green, are far more intense than the pulsative images of the yellow, the blue and the violet portions of the spectrum. Accordingly, if we make an orange colour-patch by combining red and yellow rays, it is not surprising to find that its pulsative image is blue-green, hardly differing at all from that of red, instead of sky-blue, which is the colour of the ordinary after-image of orange. Now the pulsative image of a patch illuminated by the simple orange rays of the spectrum is also found to be blue-green; hence the inference is clearly suggested that the spectral orange rays excite a red sensation. This particular fact will probably be regarded as one which needs no demonstration, but it is mentioned as an illustration of the proposed method of analysis. Several others in which the conclusions can be verified by trial might be given. Now it is noticed that under most ordinary conditions the purple pulsative image of green is more easily produced than that of any other colour. Under the same conditions we find that the pulsative images of yellow, of blue and of white are purple, and, assuming that the test referred to is a sound one, we conclude that yellow, blue and white all excite a green sensation. The proposed method of analysis may probably be carried much further than has yet been done.

This paper also contains an account of some new observations upon a class of phenomena to which I have drawn attention in a former communication (*Proc. Roy. Soc.*, vol. lx. p. 368; NATURE, vol. lv., p. 367). If the image of a white object is suddenly formed upon the retina after a period of darkness, the object generally appears to be surrounded for about one-tenth of a second by a narrow red border. It was noticed that when the bright object producing the image was looked at through variously coloured glasses the red border did not appear unless the glass used was capable of transmitting red light, and it was suggested that the phenomenon was due to sympathetic excitation of the "red nerve-fibres" lying immediately outside the portion of the retina directly affected by the radiation. The orange and yellow glasses employed for the observations referred to of course transmitted red light. Using the pulsative image apparatus with the eyepiece method, I now find that the simple red, orange and yellow rays of the spectrum, whether alone or in conjunction with any others, are competent to produce the red borders. The effect stops short at the beginning of the greenish-yellow. When blue and green rays are employed to illuminate the patch, either separately or in combination with each other, a blue-green border is produced. This is less intense than the red one before referred to, but if viewed in the manner described in the paper, the appearance of the green border due to pure spectral blue light of about $\lambda 4700$ is very striking. Violet produces no coloured border of the kind, and its admixture with other rays has no sensible effect upon the phenomenon. It can hardly be doubted that effects which occur, sympathetically as is suggested, just outside the boundary of the physical image, must also occur within the boundary; and if that is so, it follows that red, orange and yellow rays, nearly up to the beginning of the greenish-yellow, excite a red sensation, while green and blue excite a green sensation. There is at present no evidence of the same kind as to the existence of any other fundamental colour-sensation, though there must, of course, be at least one more.

The bearing of these border experiments upon theories of colour-vision is indicated in the paper. The following is among the most important points referred to. It is found that a comparatively small proportion of red mixed with other spectral rays results in the formation of a red border. According to the Young-Helmholtz theory, green spectral rays excite the fundamental red sensation to about the same extent as orange-red rays; yet no red border is formed by the green, though that formed by the orange-red is very strong. The natural deduction is that no red sensation is excited by green light.

As regards a different point which has been much debated, certain observations seem to be absolutely conclusive. According to Helmholtz the phenomena of simultaneous contrast are due entirely to mental judgment; according to Hering their origin is a physiological one. Experiments with one of the eyepiece methods, in which the apparent diameter of the pulsative image is about one-fourth of that of the white-light disc or field of view, seem to place the matter beyond dispute. If a purple pulsative image is produced from a strongly illuminated green colour-patch, the whole of the physically white field surrounding the patch appears to be purple. It cannot possibly be that the colour of the ground is a psychological effect resulting simply from contrast with green, for no green whatever is consciously perceived; the cause must necessarily be of a physiological nature. A similar effect is produced in an even more striking degree by blue and by violet colour-patches, the whole field appearing to be of the same hue as the pulsative images, namely orange and yellow. Phenomena of simultaneous contrast, as they are called, are therefore certainly not in all cases to be explained solely on psychological grounds.

The experiments which have been discussed establish nothing decisively in favour of either of the two principal theories of colour-vision. Some of the observations seem to support the Young-Helmholtz theory, others that of Hering; others, again, appear to indicate that neither theory in its present form is tenable. I venture to think that our knowledge of the subject might be materially increased by further experiments on the lines of those described.

SHELFORD BIDWELL.

THE SECOND INTERNATIONAL CONFERENCE FOR THE EXPLORATION OF THE SEA.

AFTER the International Conference which met at Stockholm in June 1899 for the consideration of a scheme for the systematic scientific study of fishery questions, it was proposed to meet again to complete the programmes at Christiania in the autumn of 1900. Various circumstances made it necessary to postpone the meeting, which eventually took place in the second week of May, when representatives of Germany, Belgium, Denmark, Finland, Great Britain, Norway, Holland, Russia and Sweden (the order is that adopted in the official *compte-rendu*—alphabetically in the French language), to the number of twenty-five, assembled in Christiania. The delegates included Dr. Herwig, president of the German Society for Promoting Sea-fisheries; Profs. Krümmel and Brandt of Kiel, and Profs. Heincke and Henking from Germany; Prof. Gilson of Louvain from Belgium; Captain Drechsel, Dr. Martin Knudsen and Dr. C. G. J. Petersen from Denmark; Dr. Nordqvist from Finland; Sir Colin Scott Moncrieff, Prof. D'Arcy Thompson, Dr. H. R. Mill and Mr. W. Garstang from Great Britain; Prof. Nansen and Dr. Hjort from Norway; Dr. P. P. C. Hoek from Holland; Dr. Knipovich from Russia; and Profs. Pettersson and Cleve, Dr. Trybom, Captain Maechel and Messrs. Wijkander and

Ekman from Sweden. Dr. H. H. Gran and Mr. K. V. Hammer acted as secretaries, and Profs. G. O. Sars and Mohn were invited to take part in the deliberations of the Conference.

The Norwegian Government received the Conference, the Prime Minister, Mr. Steen, acting as host, and very cordial messages were received from the King. The Municipality of Christiania also showed a lavish hospitality, and everything that could be done to promote the comfort of the delegates had been thought of and provided for. The meeting lasted from Monday, May 6, to Saturday, May 11, and the work—either in the full meetings, in committees, or, by no means least important, in personal conversation—was practically continuous from early morning till past midnight. The result was, on the whole, highly satisfactory; concessions had doubtless to be made all round, and some conclusions which might not be the best conceivable had to be accepted as the best obtainable; but the harmony of the international fellow-workers was unbroken, and during the whole meeting no question had ever to be put to the vote, agreement in every case being unanimous. The president of the Congress was Prof. Nansen, but the chief delegate of each of the chief countries represented presided each on one day.

The first work was the revision and completion of the Stockholm programme in its two divisions, which were known as the hydrographical and the biological. The former division, having been well elaborated at Stockholm, was easily disposed of, but the biological programme was entirely recast, several independent schemes of work which had been brought forward by the delegates having to be combined with the provisional programme. Next came the question of the organisation of the scheme of international research, which was only partially achieved. As it was necessary to refer several points to the various Governments concerned, it was decided that a committee of the vice-presidents should draft a series of recommendations to be sent in the same form to all the participating Governments, but not to be made public until a decision had been arrived at. Finally, a number of resolutions in the form of "pious opinions" were proposed and adopted.

The introductory clause of the official report, referring to the complete programme, runs: "Gonsidering that a rational exploitation of the sea should rest as far as possible on scientific inquiry, and considering that international cooperation is the best way of arriving at satisfactory results in this direction, especially if in the execution of the investigations it be kept constantly in view that their primary object is to promote and improve the fisheries through international agreements, this International Conference resolves to recommend to the States concerned the following scheme of investigations which should be carried out for a period of at least five years."

A. *Hydrographical Work.*—The object of this work is defined as the distinction of the different layers of water according to their geographical distribution, depth, temperature, salinity, dissolved gases, plankton (as an index of movement of water) and currents. To effect this object it is recommended that simultaneous observations should be made in the North Sea, English Channel, Baltic and North Atlantic along certain definite lines four times in the year, the middle point of the series of observations being in the first half of February, May, August and November. Instruments and methods are prescribed, and it is provided that meteorological as well as oceanographical observations shall be made, and that facilities shall be offered to the various national meteorological offices to cooperate in the study of the upper atmosphere at sea by the use of kites. The observations made on each of the international trips are to be plotted on synoptic charts at the earliest possible date after the return of the vessels. Stress is laid on the provisional nature of any determinations of salinity or density made at sea, and on the importance of carrying out such observations with the highest precision in laboratories on shore. The unit of depth is to be the metre, although it is allowable to add the depths in fathoms. The sea-mile is to be the unit of horizontal distance. For temperature, thermometers graduated in either centigrade or Fahrenheit degrees may be used, but all readings are to be reduced to centigrade for publication. While the new tables of the physical constants of sea-water prepared by Dr. Martin Knudsen, of Copenhagen, are to be employed, and are sufficient for their purpose, it is pointed out that it is desirable to have the existing tables of the absorption of atmospheric gases in sea-water revised. The mapping of the deposits on the sea-bed of the area to be studied is another desideratum to which attention is called. It is also pointed out that it is desirable to encourage regular observations of surface temperature and the collection of samples of surface water on board the steamers of regular lines which cross the area under investigation, a branch of work which has yielded excellent results in the hands of the Danish Meteorological Institute and in those of Mr. H. N. Dickson.

B. *The Biological Programme.*—Here two classes of recommendations are to be distinguished, those referring to obligatory work which each of the nations concerned is held bound to carry out, and to optional work, which, while desirable in order to complete the scheme of investigation, is not of such urgent importance. The areas in which the various nations are to work are suggested both for the hydrographical and the biological researches. Briefly put, they provide that the North Sea south of 58° N. should be divided by the meridian of 2° E., to the west of which British vessels should do the work, to the east of which Belgium, Holland, Germany and Denmark should undertake the sections lying off their own coasts. From 58° to 62° N., Great Britain, Norway and Denmark would share the work in the North Sea and North Atlantic. From 62° northward would be the sphere of interest of Norway in the Atlantic and of Russia off the Murman coast. The Baltic and its approaches would be dealt with by the three Scandinavian nations, together with Germany, Russia and Finland. No objection would be made to any of the research vessels extending their operations beyond the area allotted to them provided that the work in that area is not neglected.

The biology of food fishes is to be investigated in a comprehensive manner. The preparation of charts is recommended, showing the distribution in all their stages of growth of plaice, sole, turbot, cod, haddock and herring in the North and Arctic Seas, and of flounder, cod, sprat and herring in the Baltic. The observations to yield data for these charts are to be carried out as often as possible and with uniform trawls and other appliances, while the measurement and all particulars of the fish caught are to be recorded in a systematic and uniform manner.

In this respect optional researches are suggested on the life-history of food fishes with regard to their development, migrations and feeding places, all in connection with hydrographical conditions. To help towards this end the liberation of marked fish over wide areas and in large numbers is recommended. It is also considered useful to inquire as to whether fish of different species after being caught by various methods are likely to live if immediately liberated.

The study of the quantitative distribution of pelagic eggs, larvæ and young fishes is to be carried out as part of the routine work at all stations where physical observations are made, the method recommended being by vertical hauls of Hensen's large egg-net. As an optional extension of this part of the work the study of the eggs and young of food fishes may be continued in the intervals between the quarterly cruises, and experiments should be made on the artificial fertilisation and hatching of ova.

The researches of individual specialists are to be promoted by the collection of material as to the local varieties of plaice, herring and mackerel in the entire area subject to international investigation, and such researches may also be extended to include other useful species. The areas where undersized or immature fish specially abound are to be very carefully inquired into, and the quantity of such fish landed at the various ports as the result of various methods of fishing are to be ascertained. The statistical methods may be extended by the occasional sending out of experts on board fishing vessels to examine the catch as it is brought on board.

The study of plankton and bottom fauna is to be carried out by qualitative samples being collected as one of the routine operations at the various stations for hydrographic observations on the quarterly cruises, not merely from the surface, but by vertical hauls. Where possible, similar collections at other times and at regular shore stations is recommended as an optional extension. Quantitative hauls with Hensen's plankton-net are also recommended, the material collected being offered for examination to specialists who may be willing to undertake the work of quantitative determination. Endeavours should be made with suitable apparatus to investigate the organisms which inhabit the lowest water layers immediately above the bottom. The macroscopic animal and plant life of the bottom should also be studied, with special reference to the nutrition of food fishes. Among the optional researches which are suggested with reference to the bottom fauna are observations on the bacteria of the bottom and of the water immediately above.

The last section of the biological programme deals with the importance of elaborating fishery statistics so as to yield data for constructing maps of the fishing grounds, and for determining the influence of physical conditions on fish.

With regard to the apparatus to be used in these observations, Prof. Nansen, Dr. Hjort and Mr. Garstang gave a demonstration on board the *Isbjorn* in Christiania fjord of the insulating water-bottle as used for exact measurements of temperature, and of various forms of closing tow-nets.

C. *Organisation of the International Council, Central Bureau and International Laboratory.*—The organisation which is to put the elaborate system of observations recommended by the Conference into operation and to record and work out the result is obviously the most important part of the whole scheme, as upon its successful working depends the whole of the success of the attempt at concerted action. The International Council is thus described :—

"The permanent International Council shall consist of commissioners elected by the Governments interested. Each Government should appoint two commissioners who may be represented at meetings by substitutes, and may be accompanied by experts who, however, shall not be competent to vote.

"The council elects its president and vice-president and appoints all officials of the Central Bureau. Should the general secretary represent hydrographic science, one of his principal assistants should be a biologist, and *vice versa*. The other assistant shall preferably be experienced in statistical work. . . .

"It will be for the Governments concerned to decide among themselves the amount of the contributions to the Central Organisation. The expenses of the Central Organisation are approximately estimated at 4800*l*. yearly. . . .

"The purpose of the Central Bureau will be :

"To give uniform directions for the hydrographic and biological researches in accordance with the resolutions drawn up in the programme of the present Conference, or in accordance with such modifications as may be introduced later with the consent of the States represented.

"To undertake such particular work as may be entrusted to it by the participating Governments.

"To publish periodical bulletins which shall contain the actual data obtained in the cruises of all the participating States at the earliest possible date, and also such other papers as may prove useful in coordinating the international work. . . .

"The site of the Central Bureau, to be decided by the Governments concerned, shall at the same time be the residence of the general secretary.

"The purpose of the International Laboratory shall be :—

"To control apparatus and to ensure uniformity of methods. The various apparatus and instruments now used for oceanic research should be examined in order to settle which are the most trustworthy. Experiments may also be made to improve the apparatus and instruments or to construct new and better ones.

"The water-samples sent by the workers of the participating States are to be analysed and examined at the Central Laboratory, from which also samples of standard water should be provided. . . .

"The International Laboratory is subordinate to the Central Council, to which its accounts shall be rendered. Its operations shall be reported to the Central Bureau.

"The site of the Central Laboratory shall be decided by the Governments concerned, and should be conveniently situated for oceanic researches."

The relations of the Central Bureau and the International Laboratory will probably be somewhat difficult to define, and the success of the two practically independent institutions will depend on the strength and tact of the International Council, the selection of the members of which will devolve upon the Governments associating themselves with the work.

Resolutions.—The general resolutions adopted by the Conference included an expression of the desirability of the provision of at least one steamer specially adapted for marine research by each of the participating States. This is so self-evident as hardly to require statement. Norway already possesses such a vessel in the *Michael Sars*, which has already done excellent work under Dr. Hjort; Russia has also equipped a vessel for fishery observations, and Germany has sanctioned a very carefully-planned ship, involving some very important innovations, which is now, we believe, almost ready to be launched. To carry out the British share of the work properly two vessels will be required, and for so promising a field of practical application of science it seems reasonable to hope that they will be provided.

The opinion is formally expressed that the Central Bureau should commence operations as soon as possible, and not later than the beginning of next year, while the first set of international cruises should take place not later than May 1902. To make this possible it is recommended that the International Council should meet in Copenhagen as soon as the participating Governments decide to accept the programme of the Conference.

A resolution expresses sympathy with the efforts of Governments which are endeavouring in the face of difficulties from foreign trawlers to preserve an area, such, *e.g.*, as the Moray firth, from fishing operations, for experimental purposes. Another thanks Dr. Knudsen for his recently published hydrographical tables, in which he gives a new determination of the physical constants of sea-water. The remaining resolutions suggest methods for graphically representing the dynamics of oceanic movements, approve of the inclusion of observations on fresh-water lakes simultaneous with, and similar to, those on the sea, and point out the importance for deep-sea fisheries and for weather forecasts of bringing the Faeroes and Iceland into the telegraphic system of Europe.

It remains now for the Governments of the northern marine nations of Europe to give effect to this carefully planned scheme.

H. R. M.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The following is the text of the speech delivered by Prof. Love in presenting Dr. P. L. Sclater for the degree of D.Sc. *honoris causa*, on June 20:—

Adest Philippus Lutley Sclater, Sodalis Societatis Regalis, Magister Artium in Academia nostra, Philosophiæ Doctor in Bonnensi, Collegii Corporis Christi Socius honoris causa creatus. Qui vir, ut primos eius annos et incunabula laudis breviter præstringam, si quis alius, vere Wiccamicus vocandus est, cum non solum ipse et postea duo eius filii sed olim pater atque avus in illustrissima Schola Beatæ Mariæ de Winton instituti sint. Ita per quattuor hominum ætates huius domus nomen in annalibus Wiccamicis notissimum. Nostræ mox Academiæ particeps et Collegii Corporis Christi alumnus duos fere et quinquaginta abhinc annos graduatus est.

In ὀρνιθολογίᾳ quam vocant hic profecto familiam ducit : hoc gubernante Societas Zoologica Britannica laude maxima floret; horti autem Zoologici Londinenses nullis usquam cedunt. Quod ad doctrinam exquisitiorem et rei Zoologicæ peritiam attinet, illud potissimum dixerim, hunc regionum Zoologicarum naturam et limites primum perspexisse cum regionibus sex constitutis, Palæarctica, Nearctica, Neotropicali, Æthiopica, Orientali, Australi, orbem terræ non hominum civitatibus sed ferarum generibus partiretur. Quam rationem quinquaginta fere abhinc annos excogitatam plurimi ita emendare et corrigere conati sunt, quo in numero erat ipse Huxley, vir in hoc genere doctrinæ præstantissimus, ut etiam hodie probatissima et naturæ convenientissima esse videatur. Multa docuit hic vir ingeniosissimus quæ adhuc omnium iudicio comprobantur, velut Africæ septentrionalia harenosæ Nomadum solitudini superiacentia re vera Palæarctica esse atque Europæ affinia; Arabiæ autem meridiana in regionem Africanam sive Æthiopicam cadere : de duabus etiam Americæ continentibus felicissime monuit, hanc ab illa divioi, non isthmo illo Panamensi, sed septentrionali Mexicæ latere, cum ultra citraque hanc quasi lineam accuratissime descriptam diversissima ferarum genera inveniantur.

SIR HENRY ROSCOE, F.R.S., has been elected Vice-Chancellor of the University of London for the ensuing year.

PROF. J. G. MACGREGOR, F.R.S., professor of physics in Dalhousie College, Halifax, Nova Scotia, has been elected to succeed Prof. Tait as professor of physics in the University of Edinburgh.

DR. F. H. NEWMAN, of the Royal College of Science, London, has been appointed director of technical education and principal of Tullie House, Carlisle. Tullie House consists of a public library, museum and school of art. It is the intention of the committee to build a technical school at an early date, the land having been already purchased. Dr. Newman commences his duties on July 1.

REPLYING to a question as to the terms of reference to the Royal Commission on University Education in Ireland, in the House of Commons on Thursday last, Mr. Balfour said they were as follows:—"To inquire into the present condition of the higher general and technical education available in Ireland outside Trinity College, Dublin, and to report as to what reforms, if any, are desirable in order to render that education adequate to the needs of the Irish people." The chairman is Lord Robertson, and among the other members are Profs. Ewing, Rücker and J. Lorrain Smith.

IN opening an exhibition of practical work done in connection with the City and Guilds of London Institute, at the Imperial Institute, Lord Avebury referred to the dependence of technological instruction upon the sound teaching of science, and some defects of school work in general, when considered from an educational point of view. He pointed out that our great public schools were bound under the regulations of the Public School Commission to give one-tenth of the marks in all examinations to science and one-tenth to modern languages. But this obligation was systematically ignored. At the greatest of our schools there were twenty-eight classical masters, thirteen mathematical, and only four science masters for more than 900 boys. The University of London, which he had the great honour of representing in Parliament for more than twenty years, had always taken a leading part in endeavouring to secure for science its proper place in our educational system. It was the first to give science degrees. It made a knowledge of science an obligatory part of the matriculation examination, that no University degree should be given to any one who, taking the line that literature, science and mathematics were necessary elements in any well-though-out education, was not well grounded in all three. It was difficult to over-estimate the important and beneficial effect which this had had on our secondary schools, and he deeply regretted that it had been proposed to drop science out of the list of obligatory subjects in the matriculation examination. It was greatly to be hoped that the Senate would not adopt a recommendation which was so retrograde and so opposed to the whole traditions of the University, and which he did not hesitate to say would be a national misfortune. The Chambers of Commerce did not wish, nor, he was sure, did scientific men wish, to exclude classics. What they pleaded for was that science, the knowledge of the beautiful world in which we lived, should not be excluded.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, June.—The number opens with an account of the proceedings at the two April meetings of the Society. The Chicago section held its meeting at the University of Chicago on April 6. Ten papers were read, and abstracts of the papers are edited by Prof. T. F. Holgate. The other meeting was held in New York City on April 27. To relieve the increasing burden of administration, Dr. Edward Kasner was appointed assistant secretary, to serve until February 1902. This gentleman reports the proceedings and gives abstracts of several of the seventeen papers which were communicated.—The value of

$$\int_0^{\frac{\pi}{2}}(\log 2\cos\phi)^m\phi^n d\phi$$

is a notelet which was read before the April (1899) meeting of the Society by Prof. F. Morley.—Dr. Kasner's paper on the algebraic potential curves (read February 23, 1901) has for its object the derivation of the characteristic geometric properties of a class of curves which are of interest in connection with the theory of equations and of the potential function. Analytically, these curves are obtained by equating to zero the rational integral solutions $\phi(x, y)$ of Laplace's equation

$$\Delta\phi \equiv \frac{\partial^2\phi}{\partial x^2} + \frac{\partial^2\phi}{\partial y^2} = 0,$$

or, what is equivalent, the real (or imaginary) parts of the rational integral functions of $x+iy$.—Various geometric properties are given in Briot and Bouquet's "Théorie des Fonctions Elliptiques" (book iv. chap. ii.), but none are completely characteristic. The several sections treat of (1) apolarity with respect to a point pair, (2) polar properties of potential curves, (3) focal properties, (4) the asymptotes, and (5) the connection with the theory of equations. Several useful references are given in footnotes.—The reviews are of Steinmetz's "Alternating Current Phenomena," by J. B. Whitehead, jun., and of de Tannenberg's "Leçons Nouvelles sur les Applications Géométriques du Calcul Differential," by L. P. Eisenhart.—The usual information follows in the notes and new publications.

American Journal of Science, June.—The new spectrum, by S. P. Langley. A short account of the methods adopted for mapping the spectrum in the ultra-red. The paper is accompanied with a map of this spectrum for wave-lengths between 0·76 μ and 5·3 μ.—On the rival theories of cosmogony, by O. Fisher. A discussion of the meteoric and nebular hypotheses. A study of some American fossil Cycads. Part iv. On the microsporangiate fructification of Cycadeoides, by G. R. Wieland. It was suggested in a previous paper that the sorus-bearing axis is a series of twelve fused leaves or fronds with their sorus-bearing pinnacles turned inwards. More extended study of additional material in a far superior state of preservation has confirmed the above hypothesis as a correct one.—Studies of Eocene mammalia in the Marsh collection in the Peabody Museum, by J. L. Wortman. A continuation of a previous paper.—On the cæsium-antimonious fluorides and some other double halides of antimony, by H. L. Wells and F. J. Metzger. A description of the mode of preparation and properties of five double salts of the composition $CsF.3SbF_3$, $CsF.2SbF_3$, $4CsF.7SbF_3$, $CsF.SbF_3$ and $2CsF.SbF_3$, mohawkite, by J. W. Richards.—The life-work of Prof. H. A. Rowland, by H. F. Reid.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 28.—"On the Results of Chilling Copper-Tin Alloys." By C. T. Heycock and F. H. Neville.

Sir W. Roberts-Austen and Dr. Stansfield have shown that the cooling curves of many copper-tin alloys exhibit well-marked "arrest points," or halts in the cooling due to the evolution of heat. From the temperatures at which these halts occur it is certain that many important changes take place long after the alloy has apparently become solid. Thus the authors find that an alloy of the composition $Cu_{81}Sn_{19}$ shows well-marked halts in cooling at the temperatures 754° C., 743° C., 558° C. and 490° C., the temperature at which solidification appears complete being but little below the second of the numbers. The exact nature of the changes causing the lower halts has until recently been obscure, but Prof. Roozeboom, by his paper on "Binary Systems Producing Mixed Crystals," has thrown much light on these phenomena.

The present paper is an attempt to apply Roozeboom's theory to the copper-tin alloys.

The authors, by slowly cooling small ingots of alloy to definite temperatures near the "arrest points" of the cooling curve, and then suddenly chilling them by immersion in water, have been able to prevent the subsequent changes due to slow cooling from taking place. The structures formed during the slow cooling down to the moment of chilling were thus fixed and could be examined.

It follows from Roozeboom's theory that in the solidification of a liquid mixture that can form mixed crystals the crystals first formed will generally differ in composition from the liquid, but that these crystals will change in composition as the solidification proceeds, and that in many cases at temperatures slightly below that of complete solidification the solid will consist of a uniform mass of mixed crystals. He further discusses the possibility of the solid solution thus formed breaking up into separate phases by crystallisation in the solid at lower temperature.

This paper contains photographs of three chills of the same alloy, $Cu_{81}Sn_{19}$, which illustrate these changes. In the first case the alloy was chilled at 740° C. (Fig. 1), while it was still partly fluid, and the photograph shows large primary combs much richer in copper than the mother substance.

Another portion of the same alloy was chilled at 630° C. (Fig. 2), a temperature at least 100 degrees below that of solidification. Even when etched or attacked in a variety of ways this sample shows no detail indicating any difference of composition; it appears to be homogeneous, or very nearly so. It has reached the stage of uniform mixed crystals.

Another fragment was chilled at 500° C. (Fig. 3), close to the lowest "arrest point." The photograph shows that crystallisation has taken place in the solid solution and that a substance rich in tin has crystallised in rosettes and bands, leaving a mother substance rich in copper.

These alloys, after polishing, were prepared for photography by slightly oxidising the surface by gently heating them in air, the temperatures needed to bring out the pattern in this way being far below those at which changes in the structure of the alloy occur. When treated thus, the parts rich in copper oxidise, and therefore darken, more rapidly than those rich in tin, hence the dark parts in the photographs correspond to matter rich in copper, and *vice versa.*

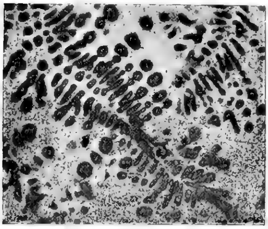


FIG. 1.—Chilled at 740°.

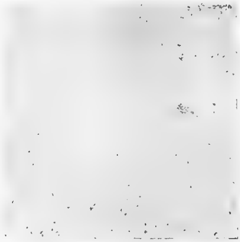


FIG. 2.—Chilled at 630°.

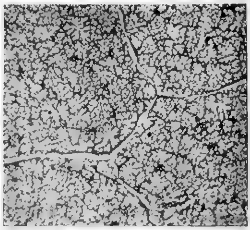
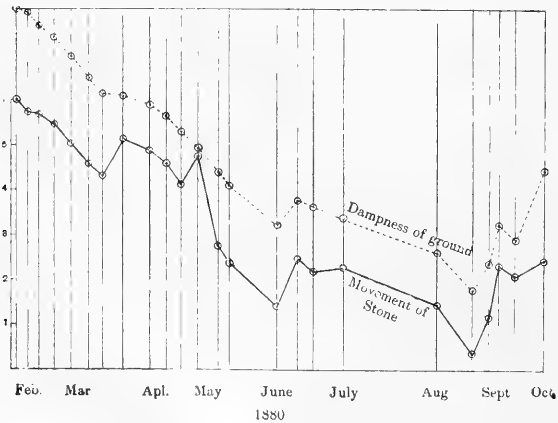


FIG. 3.—Chilled at 500°.

The authors have found similar, though sometimes more complex, phenomena throughout a considerable range of composition. The results lead to the conclusion that it is unwise to interpret a freezing curve by the examination of slowly-cooled alloys only.

May 2.—"On the Small Vertical Movements of a Stone laid on the Surface of the Ground." By Horace Darwin. Communicated by Clement Reid, F.R.S.

The experiments described in this paper were undertaken originally to measure accurately the downward movement of a stone caused by earthworms. The upward and downward movements due to varying moisture of the soil and to frost were found to be much larger than was expected. These movements,



interesting in themselves, increase the difficulty of accurately determining the movement due to the action of earthworms.

To obtain a fixed point from which to measure the displacement of the stone a rod was driven into the ground to a depth of 2·63 metres. The top of this rod was the point from which all measurements were taken.

A circular stone about 460 mm. in diameter and about 57 mm. thick, weighing about 23 kilos., was placed on the ground with the rod projecting through a hole in its centre.

A screw micrometer graduated to ·01 mm. was used. The screw was turned until its end just touched the end of the rod; owing to an unforeseen cause of error the measurements were not trustworthy to the last place of decimals. However, when care was taken to avoid this error, consecutive readings agreed to less than this amount, showing that the method was capable of greater accuracy than was required. Errors caused by the growth of the roots of a tree near the stone, swelling of the soil due to dampness, and the expansion of the rod from change of temperature are discussed.

The movements of the stone are represented graphically; the figure reproduces one of the diagrams.

The curve marked "Movement of Stone" represents the up and down movements of the stone from February 19 to October 9, 1880, due to the varying dampness of the ground.

The points corresponding to each observation are surrounded by a small circle; their vertical distance apart is proportional to the movement of the stone, each division of the scale representing 1 mm.; the horizontal distance apart is proportional time.

The curve shown by the dotted line roughly represents the dampness of the soil. Moisture is assumed to leave the soil at a uniform rate; the ordinates are proportional to the rainfall less this assumed amount evaporated or drained away; both quantities are calculated from February 19. The curves follow each other, showing that the stone fell as the soil became dryer and rose again with rain. In May there is a marked exception; the most probable explanation is an error in reading the micrometer. The total downward movement from February 19 to September 7 is 5·6 mm. On another occasion artificially wetting the ground raised the stone 0·6 mm.

Measurements taken in the winters of 1878 and 1886 show that the stone sank about 2·2 mm. per year. Measurements were also taken in the summer of most years from 1878 to 1896. The downward movement was not regular, and it is shown that this also is partially due to the varying dampness of the soil. From 1878 to 1887 the stone sank on the average about 2·3 mm. per year, and from 1887 to 1896 about ·36 mm. per year.

The effect of frost is to raise the stone; it fell rapidly during a thaw—on one occasion 2·3 mm. in 4 hours 40 minutes.

June 6.—"The Measurement of Ionic Velocities in Aqueous Solution, and the Existence of Complex Ions." By B. D. Steele, B.Sc., 1851 Exhibition Scholar (Melbourne). Communicated by Prof. Ramsay, F.R.S.

The method of measuring ionic velocities described by Masson has been extended in such a manner that, by the present method, the use of gelatin solution and of coloured indicators is not necessary.

An aqueous solution of the salt to be measured is enclosed between two partitions of gelatin which contain the indicator ions in solution, the apparatus being always so arranged that the heavier solution lies underneath the lighter. On the passage of the current the ions of the measured solution move away from the jelly, followed at either end by the indicator ions; the boundary is quite visible in consequence of the difference in refractive index of the two solutions. The velocity of movement of the margins is measured by means of a cathetometer, and the ratio of the margin velocities gives at once the ratio of the ionic velocities.

The velocities of a large number of ions at different concentrations of different salts have been calculated, and the velocities of the hydrogen and hydroxyl ions have been also measured, with the following results:—

	Found.	Calculated.
OH in KOH, 0·5 N	0·001435	0·00145
,, NaOH, 0·2 N	0·00158	0·00152
H in HNO_3, 0·2 N	0·00282 / 0·00272	0·00280

The ratio of the current, as measured by the galvanometer, to that calculated from the velocity of the margins in the manner indicated by Masson, is found to be equal to unity only for a few salts of the type of potassium chloride; for other salts this ratio has a value in some cases greater, in others less, than 1. The same irregularity has been previously pointed out by Masson for the gelatin solutions of the sulphates of magnesium and lithium.

The attempt is made to explain this deviation from the requirements of theory, and also the difficulty that Kohlrausch is unable to assign to dyad elements any value for the specific ionic velocity, which is the same when calculated from the measurements of different salts of the same metal, by the assumption, first advanced by Hittorf, that, in concentrated solutions of these salts ionisation takes place in such a manner that there are formed complex ions in addition to simple ones; and the conclusion is drawn that, in all cases where any considerable change in transport number occurs with changes in concentration, complex ions are present to a greater or less extent.

Zoological Society, June 4.—Dr. W. T. Blanford, F.R.S., vice-president, in the chair.—A communication by Dr. R. Broom, on the structure and affinities of the Anomodont genus Udenodon, was read. It contained an account of a number of specimens from the Lower Karoo beds of Pearston, South Africa, which the author referred to the Dicynodont genus Udenodon [Oudenodon]. One of these, a small skull, was shortly described as the type of a new species (*U. gracilis*).—A communication was read from Mr. Oldfield Thomas, F.R.S., in which he gave the history of the specimen of *Rhinoceros lasiotis*, Sclater (which had lived for thirty-two years in the Society's Gardens), and stated that he was of opinion that it was not deserving of specific rank, but should be considered rather as a subspecies of *R. sumatrensis*. The generic nomenclature of the rhinoceros was also examined, and it was proposed that the existing species of this family should be divided into three generic divisions—Rhinoceros (to include *R. unicornis* and *R. sondaicus*), Dicerorhinus (to include *R. sumatrensis* and *R. sumatrensis lasiotis*), and Diceros (to include *R. simus* and *R. bicornis*). It was shown that, if it were found necessary to divide the species *R. simus* and *R. bicornis*, the former, with its fossil allies, should bear the name Coelodonta.—Mr. G. A. Boulenger, F.R.S., read a paper on a small collection of fishes from the Victoria Nyanza which had been made by the order of Sir H. H. Johnston, K.C.B. Six species were enumerated and remarked upon, two of which (*Labeo victorianus* and *Discognathus johnstoni*) were described as new.—Mr. F. E. Beddard, F.R.S., described six new species of earthworms of the genus Benhamia from Tropical Africa.—A communication was read from Mr. J. G. Millais containing some notes on the capture of a specimen of Bechstein's Bat (*Vespertilio bechsteini*) in the neighbourhood of Henley-on-Thames. So far as was known, this was only the second occurrence of this species recorded in Great Britain.—Mr. H. R. Hogg read a paper on the Australian and New-Zealandian spiders of the suborder Mygalomorphæ. The author adopted the nomenclature of M. Simon, and stated that of the seven subfamilies of this suborder into which M. Simon had divided it, six were represented in Australia and New Zealand, the only absentee being the Paratropidinæ of South America.

Entomological Society, June 5.—The Rev. Canon W. W. Fowler, president, in the chair.—Mr. G. C. Champion exhibited a male specimen of *Odontaeus mobilicornis*, one of the rarest of British beetles, captured at Woking on May 28.—Mr. R. McLachlan exhibited four specimens of a curious bug of the genus Henicocephalus received from Mr. G. V. Hudson of Wellington, New Zealand, not previously noticed in that country. Mr. Champion said that Henicocephalus was generally recognised as a type in itself of a family, and Mr. Kirkaldy that it was much commoner than generally supposed. It was probably only an aberrant form of the Reduviidæ, having no stridulating apparatus on the prosternum.—Mr. C. P. Pickett exhibited varieties of *Smerinthus tiliae* bred during May 1900-1.—Mr. C. G. Barrett exhibited imagines, cocoons, pupa skins, and also water-colour sketches of larvæ, reared and drawn by Miss Frances Barrett, at Buntingville, Pondoland, S. Africa.—Dr. A. Jefferis Turner exhibited specimens of Australian wood-boring Lepidoptera belonging to four different families. They included examples of Pyralidæ, Gelechidæ, Cossidæ and Hepialidæ.—Mr. H. Goss exhibited for Mr. Ernest Ardron, of Colombo, Ceylon, two specimens of a species of Phyllium (Phasmidæ). They bore an extraordinary resemblance to leaves. He also showed three varieties of the male of *Melitaea Cinxia*, which he had taken on May 27 and 28 at Niton, Isle of Wight.—Mr. C. O. Waterhouse exhibited two new genera and species of Coleoptera recently described by him in the *Ann. and Mag. Nat. Hist.* from Rio Janeiro. One belonged to the aberrant Prisnidæ (*Pathocerus Wagneri*); the other (*Tetraphalerus Wagneri*) belonged to the Cupesidæ, and was remarkable for the form of its head. He also exhibited ♂ and ♀ of the curious Scarabæid, *Glyphoderes sterquilinus*, Westw., from North Argentina.—Mr. H. St. J. Donisthorpe exhibited a glove burnt by discharges of formic acid in the nests of *Formica rufa*. Prof. Poulton said that the discharges collected in tubes fluctuated greatly in strength, the strongest yielding a proportion of sixty to seventy per cent. of anhydrous acid. The discharge of *Dicranura vinula* showed a strength of about forty-five per cent.—Mr. W. Schaus communicated "A Revision of the American Notodontidæ," and Mr. H. St. J. Donisthorpe read a paper on cases of protective resemblance, mimicry, &c, in British Coleoptera.

Linnean Society, June 6. Mr. W. Currathers, F.R.S., vice-president, in the chair.—The adjourned debate was resumed on Mr. H. M. Bernard's paper on the necessity for a provisional nomenclature for those forms of life which cannot be at once arranged in a natural system.—The following resolutions were proposed by Mr. Bernard: (1) That the Linnean method of naming is well adapted for indicating affinity, and should be used for that purpose; (2) that allied forms whose affinities are not clear should be designated by some provisional method of naming; (3) that the method proposed by the author appears to promise enough to justify its temporary application to the Anthozoa. Mr. H. Groves moved as an amendment to the first resolution to omit all after the word "naming," and to substitute "is adequate for the present needs of zoology and botany." This was seconded by Dr. P. L. Sclater. The discussion was continued in order to elicit the views of those present on the resolutions proposed by Mr. Bernard, but no vote was taken.

Anthropological Institute, June 11.—Dr. A. C. Haddon, F.R.S., president, in the chair. Mr. Morton Middleton exhibited, on behalf of the South American Missionary Society, a large series of implements and other objects, including swan gullet necklaces, whalebone snares, featherwork, &c., from the Yahgans of Tierra del Fuego, and introduced Mrs. Burleigh, who spent some fifteen years among the Yahgans, and gave a number of additional data in regard to them.—Mr. G. Coffey read a paper on Irish copper celts.

Mathematical Society, June 13.—Dr. Hobson, F.R.S., president, in the chair.—The theory of Cauchy's principal values (ii.), by Mr. G. H. Hardy.—On the general form of three rational cubes whose sum is a cube, by Prof. Steggall.—Invariants of curves on the same surface, in the neighbourhood of a common tangent line, by Mr. T. Stuart.—Short impromptu communications were made by Dr. Macaulay (2) and Lieut.-Colonel Cunningham, R.E.

DUBLIN.

Royal Irish Academy, June 10.—The president in the chair.—On the creeping of liquids and tension of mixtures, by Dr. Fred T. Trouton, F.R.S. A number of experiments were described which showed that in order for a liquid to be capable of creeping over solid surfaces it must be a mixture. Ordinary paraffin, for example, does so, but a pure paraffin will not creep. It can be made to do so, however, by the addition of a suitable liquid. The added liquid must be more volatile, and must reduce the surface tension. This can be the case not only with liquids of lower surface tension, but also with liquids of higher surface tension when added in small quantities. For experiments on mixtures of liquids in general showed that the surface tension of a mixture is always less than the percentage calculated value. Thus an actual depression of the surface tension is in most cases produced by adding a liquid of higher surface tension. For this reason there are few liquids by the addition of which the creeping of, say, ordinary paraffin may be prevented, the requisite being a more volatile liquid with a very high surface tension.

EDINBURGH.

Mathematical Society, June 14.—Mr. J. W. Butters, president, in the chair. The following papers were read: (1) Note on an extension of Abel's theorem on the continuity of a power series, by Prof. Gibson; (2) The diffraction of plane waves incident obliquely on a semi-infinite plane, by Dr. Carslaw.

PARIS.

Academy of Sciences, June 17.—M. Fouqué in the chair.—Researches on chemical equilibria. The formation of insoluble phosphates by double decomposition; disodium hydrogen phosphate and silver nitrate, by M. Berthelot. In the reaction between silver nitrate and ordinary sodium phosphate, the total precipitation of the silver as phosphate takes place only when the two salts react in equimolecular proportions. Precipitates formed in the presence of an excess of sodium phosphate contain a certain amount of sodium, probably in the form of a sodium silver phosphate, which cannot be removed by prolonged washing.—On some new syntheses effected by means of molecules containing the methylene group associated with one or two negative radicles. The action of epichlorhydrin and epibromhydrin upon the sodium derivatives of benzoylacetic esters, by M. Haller. The chlorine or bromine atom is not eliminated in these reactions, but an addition product is formed. Thus epichlorhydrin with benzoylacetic ester gives a new ketolactone, the properties and reactions of which are given.—M. Maupais was nominated a correspondent for the section of anatomy and zoology in the place of the late M. Marion.—Some new nebulæ discovered at the Observatory of Paris, by M. G. Bigourdan. Positions and descriptions of twenty-one new nebulæ.—On the employment of the stereoscope in astronomy, by M. Maurice Hamy. Remarks on some possible applications of the stereoscope in astronomy, with applications to the study of the motions of stars by the Doppler-Fizeau principle, to eclipses of the sun with special reference to the internal movements of the chromosphere, and to the internal movements of nebulæ.—The equations and fundamental properties of reciprocal autopolar figures in the plane and in space, by M. Rabut.—On Fourier's series, by M. A. Hurwitz.—On the application of the theory of elasticity to the calculation of bent rectangular beams, by M. Mesnager.—On electromotive forces of contact and the theory of ions, by M. E. Rothé. An experimental study with a Lippmann capillary electrometer in which the solution could be readily changed, the solutions used being sulphuric and hydrochloric acids of varying strengths. The variations of electromotive force thus observed were compared with those calculated from the ionic hypothesis, the agreement in the case of the weak solutions being satisfactory.—The capillary constants of organic liquids, by MM. Ph. A. Guye and A. Baud. Measurements by the method of Ramsay and Shields of the capillary constants of phenetol, anisol, ethyl acetate, nitrobenzene, benzonitrile and metacresol. In all these substances, with the exception of metacresol, the value of the constant K exceeds the number 2·121 admitted by Ramsay and Shields as the value for a non-polymerised liquid, but the author adduces reasons for supposing that this does not necessarily mean that these substances are in a polymerised state.—On a new element, europium, by M. Eug. Demarçay. By a prolonged fractionation of samarium it has been possible to isolate the oxide of an element, apparently distinct from samarium, and which is capable of giving rise to the so-called anomalous ray, discovered by Crookes in the fluorescent spectrum of samarium. It is also identical with the element provisionally named *Zε* by de Boisbaudran. The name europium is proposed for this substance, with the symbol Eu = 151 about.—On the chlorobromides of thallium, by M. V. Thomas. The methods of preparation and the properties of two chlorobromides of thallium are described, having the compositions $Tl_3Cl_2Br_4$, and $TlClBr$.—The reactions of acetylene with cuprous chloride dissolved in a neutral solution of potassium chloride, by M. R. Chavastelon. The action of acetylene upon a neutral saturated solution of cuprous chloride gives the same results as when the solution is acid or alkaline.—The separation of nickel and cobalt by the electrolytic method, by M. Dmitri Balachowski. From a solution containing both nickel and cobalt salts to which ammonium thiocyanate, urea, acetic acid, and a little ammonia have been added, it has been found possible by careful attention to the voltage, and especially to the amperage, to completely separate the nickel, which comes down apparently as a sulphide. By then altering the voltage and the strength of the current the cobalt can be thrown out.—Study of contact action on the secondary and tertiary alcohols, by M. A. Trillat.—On the floral organogenesis of the disciflora, by M. L. Beille.—Diffusion in gelatin, by M. S. Leduc.—On the presence of carbon monoxide in the blood of the newly-born, by M. Maurice Nicloux. In ten estimations of the amount of carbon monoxide in the blood of a newly-born animal the amount found varied between ·08 c.c. to ·14 c.c. of CO from 100 c.c. of blood, with a mean of 0·11 c.c. The amounts were estimated by the amount of iodine set free from iodic acid, and from this reaction and the fact that the gas is totally absorbed by hæmoglobin it is quite certain that the gas is really CO.—On a biochemical differentiation of the two principal ferments of vinegar, by MM. Gab. Bertrand and R. Sazerac. The two species, *Mycoderma aceti* and *Bacterium xylinum*, can be distinguished by their different oxidising power towards glycerin.—On the extrapolar electrotonic currents in nerves without myeline, by M. Mendelssohn.—On the reaction time in different races and social conditions, by M. Louis Lapicque. The average reaction time of Europeans was found to be 0·15 second, of Hindoos 0·22 second and of Andaman Islanders 0·19 second.—The influence of the lethecines of the egg upon the nutritive changes, by MM. A. Desgrez and A. Zaky.—On the use of yeast as a means of finding out communications between sheets of water, by M. P. Miquel.

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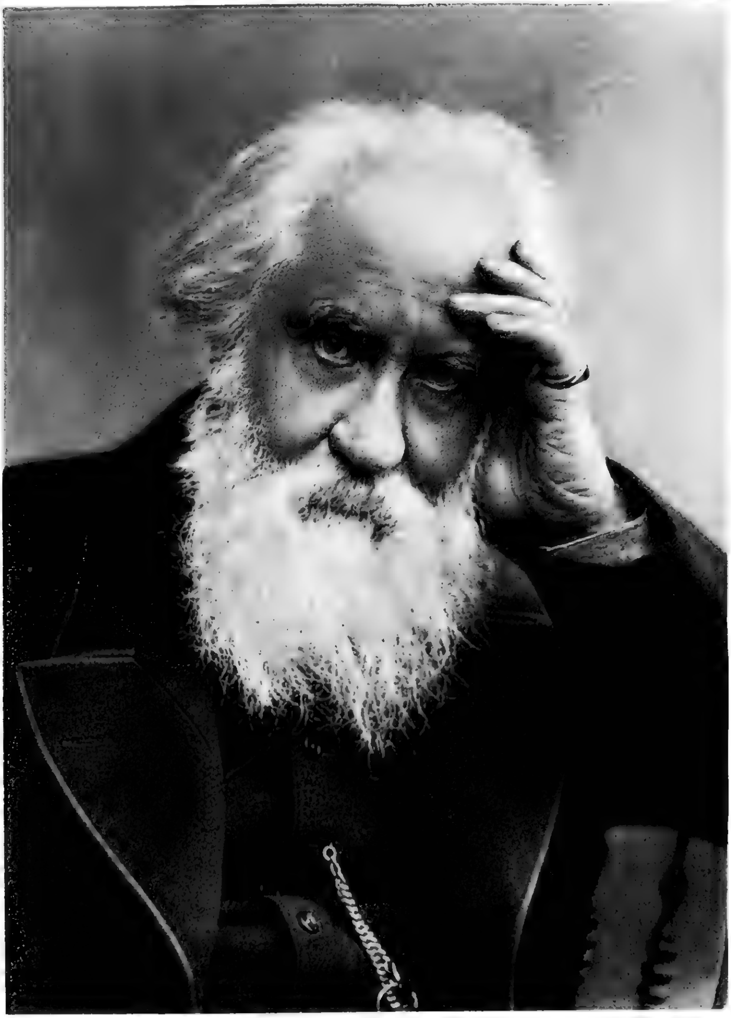


William Huggins

THURSDAY, JULY 4, 1901.

SCIENTIFIC WORTHIES.

XXXIII.—Sir William Huggins, K.C.B.

FAR from the noisy centre of London, in Upper Tulse Hill, there is a quiet house. The welcome accorded to one who has the good fortune to enter at its hospitable doors reminds one of Philemon and Baucis, and the visitor amidst the artistic decorations of the house feels transplanted into another world. In the garden extending far behind the house one sees the astronomical observatory with its dome, and recognises that this is the house of a man of science, not an artist.

We are in the dwelling of Sir William Huggins, on whom the English scientific world has lately conferred the highest honour by electing him President of the Royal Society.

Sir William has been in the happy position of being able to follow his scientific inclinations without being limited by official duties. After some hesitation he decided on Astronomy and built his observatory, the description of which is contained in his first scientific publication.

At that time, 1856, astronomy was chiefly confined to measurements of the positions of celestial bodies, but a few years later quite a new field was opened out by the great work of Kirchhoff and Bunsen, and it was Sir William Huggins who first introduced the new knowledge into astronomy and fertilised it.

The new science, Astrophysics, is in great part his work, and indeed I hardly know of another example where the history of the development of a science so nearly coincides with the story of one man.

Sir William had the good fortune to come on virgin ground everywhere, so that every observation meant a great and fertile discovery; but it is his merit that he was the first to recognise the importance of the new discovery, that he invented the best methods and instruments, and that he united in himself the necessary knowledge of Astronomy, Physics and Chemistry.

The so-called "good fortune" really plays a small part in great discoveries.

> "Wie sich Verstand und Glück verketten.
> Das sehn die Thoren niemals ein;
> Wenn sie den Stein der Weisen hätten,
> Der Weise mangette dem Stein,"

as Goethe says.

As soon as the news of Kirchhoff and Bunsen's discovery reached Huggins, he saw clearly that the application of spectrum analysis to the heavenly bodies was his field of research, and in this field he has laboured during the succeeding forty years with indefatigable ardour and never wanting success. His first researches were made in conjunction with W. A. Miller, Professor of Chemistry at King's College, who had been a worker in spectrum analysis for fifteen years.

As their first result they were able to send to the Royal Society in 1863 a Report on the Spectra of Stars. It is true Fraunhofer (1814), and Lamont and Donati (1860) had seen star spectra, but the method of observation employed by Huggins was quite different, being difficult and more fruitful. It was not at all sufficient now to see lines in the spectra of stars, but their chemical origin had to be determined; and therefore the light-gathering objective prism could no longer be used, but after the method of Kirchhoff and Bunsen a slit and comparison prism were employed. As thereby the spectrum is enormously weakened and has scarcely any breadth, Huggins introduced the cylindrical lens.

Very soon the insufficient knowledge of the spectra of the elements became obvious, and Huggins undertook with great success the task of determining the position of the lines of as many elements as possible in the visible part of the spectrum. The results were invaluable at that time, and even now, after the introduction of instruments so much more accurate, they are of value.

The year 1864 brought a great triumph for Huggins in the discovery that many of the nebulæ gave spectra consisting of bright lines. This fact was of enormous importance theoretically in consideration of the Kant-Laplace hypothesis of the genesis of the universe. Also of great importance were the observations on the new star in Corona, published by Huggins in 1866. Here he saw for the first time bright and dark lines combined in the same spectrum, and as the explanation he suggested an enormous convulsion of the star, excited, perhaps, by the approach or collision of a dark star.

In this and the following years he found opportunity to observe spectra of comets. Although they were too weak to enable him to pronounce any definite opinion on these mysterious phenomena, they sufficed to show that the light was partly reflected and partly emitted by the comets themselves. This result was confirmed when in 1868 the bright comet of Brorsen appeared, and Huggins found that its spectrum contained bright bands, which he recognised as belonging to carbon.

In the short period of five years Sir William had been the pioneer over a vast territory. Fixed stars, nebulæ, comets and even a new star were forced to disclose their mysteries. It would seem that the possibility of absolutely new discoveries were now excluded, that only the more detailed study of the same phenomena was left to science. But the genius of Huggins found new work for the spectroscope. Doppler's principle, that the wave-length of light is altered when the observer and source of light alter their distance apart, was certainly recognised as true, but nobody had thought of applying it to the extremely important case of stellar motion in the line of sight. Huggins was the first to do this, in 1868, with a new instrument, the result of some years of consideration.

The fertility of this new method, the beautiful and unexpected results which it has given in later years, is well known, and there is no doubt that in the future it will be the means of revealing to us much that at the present time remains mysterious.

At about the same time Huggins had tried to observe the prominences of the sun in the absence of an eclipse. He solved the problem and published an account of his methods, so that although he was preceded in the observation itself by Janssen and Lockyer, his high reputation was sustained. Immediately afterwards we find, as his contribution to the development of the subject, a description of a method for not only determining the chemical constitution, but also the actual shape of the protuberances.

In still another region Huggins has been a pioneer. As early as 1864 he had tried to photograph star spectra, but with his small and imperfect apparatus he only obtained spectra without lines. He did not, however, lose sight of the problem, and after the invention of dry plates he constructed a spectrograph out of rock crystal and Iceland spar which, with a Cassegrain telescope, gave the well-known beautiful spectra, among the novelties of which may be mentioned the revelation for the first time of the ultra-violet series of hydrogen.

The continued application of photography to the spectra of the various celestial bodies, the discovery of innumerable important and interesting results, occupy the following decades of a laborious life. It is impossible to follow in detail the whole of Huggins' achievements, contained as they are in nearly a hundred publications. To do so would require volumes, not one short article; nor is it possible to point out how Huggins was enabled by the construction of his spectroscopes to produce those excellent photographs which have excited our admiration during the last twenty years. There does not exist, I believe, any stellar spectrograph which does not involve in its construction ideas taken from Huggins' models. One obtains a superficial insight into the immense progress made by Huggins in the photography of stellar spectra in the book which he has presented to science under the title "Atlas of Representative Stellar Spectra," by Sir William and Lady Huggins. This and all the later publications of Sir William Huggins are signed also by Lady Huggins, in whom Sir William has found an "able and enthusiastic assistant." It would therefore be unjust not to mention Lady Huggins in a description of Sir William's work.

This necessarily very short and incomplete review, in which only a few of the most important discoveries could receive mention, while many others, such as, for instance, the detection of the band spectrum of water-vapour, had to be passed over, will show how productive and beneficent to science his life has been. The child to whom he gave life, Astrophysics, has been the object of his care and attention and has now developed into a strong and beautiful man.

The father can look with pride upon his child, and well may he be happy to see the progress which has been made and the number who now devote their energy and knowledge to this part of science.

But above all Huggins is distinguished by the extraordinary accuracy of all his publications. He has always been very cautious in drawing conclusions from observations; with an enthusiastic heart he has combined a cool head. He has scarcely ever been forced to retract or modify a statement, and therefore his views are universally accepted and his authority remains unrivalled, which I think to be the highest reward and greatest honour to which a scientific man can attain.

William Huggins was born in London, 1824. He built his private observatory in 1856, became President of the Royal Astronomical Society, 1876; President of the British Association, 1891; President of the Royal Society, 1900. He has received a Royal medal, the Rumford medal and the Copley medal from the Royal Society, and two medals from the Royal Astronomical Society. He married Miss Margaret Murray, of Dublin, in 1875.

H. KAYSER.

ENGLAND'S NEGLECT OF SCIENCE.

England's Neglect of Science. By Prof. Perry, F.R.S. Pp. 113. (London: T. Fisher Unwin, 1900.) Price 2s. 6d.

UNDER the above title Prof. Perry publishes a collection of seven short papers dealing with several questions relating to the position of science and the method of teaching it in England. The little book itself takes its title from the second of these papers, an article which appeared in NATURE in July 1900.

The subject is one of such great magnitude and intricacy that it is scarcely possible for a private individual to bring a sufficient knowledge of details to bear upon it. Nothing short of a commission of men of science would suffice to collect the mass of statistics which is necessary for the complete discussion of the shortcomings of England in her relation to scientific education. We must, therefore, be content to deal with it from a few points of view only, most of these being indicated by Prof. Perry himself.

Prof. Perry is well known to be, like several of his colleagues in science, dissatisfied with the position of science in England, with its influence in the affairs of State, and with the provision made for its support and development. When, however, he speaks of "England's" neglect of science it would be well if he made a distinction between England as a *nation* and England as a *Government.* It is not true that the English people as a whole are indifferent to the supreme claims of science in the modern world, but it is most unfortunately true that the men placed by the people at the heads of the Government departments are sadly wanting in a knowledge of science, and are, as a result, almost indifferent to its interests. Indeed, at the hands of the typical English Government official the profession of scientific education shares with science itself the results of this indifference. There is unquestionably a marked want of sympathy on the part of our Government officials with all those whose business it is to spread scientific knowledge among the people. What is the cause of this? The simple and direct answer is—the public schools. These institutions—some of them venerable as to age, all of them venerable as to ideas—supply almost exclusively the professional politicians to whose care the interests of the great departments of the Government are committed, and in all of them the dominant educational ideals are classical and mediæval. The career of the English professional politician is fairly well stereotyped. A classical education at one of the fashionable public schools, followed by something very similar at an ancient University, accompanied probably by the pursuit of some branch of athletics, and almost certainly by a continuous neglect of all branches of science, is the typical training of the heads of English officialdom. Neither science nor those whose profession is the teaching of science can hope for much encouragement from rulers developed by such a system as this. As for zeal in the promotion of invention or discovery before the thing aimed at becomes a visible and established fact, let no man look to an English Government department for that.

If the root of the public evil—England's *official* neglect of science—is to be found in the mediævalism of the public schools, the cause of the evil in the schools themselves is, to a great extent, to be sought in the *classical clerics* who are almost invariably placed over them; for very few of the head masters are men who have received any training in modern science. It is doubtful, however, if this is the *whole* cause of the unscientific character of the public schools; for in most, if not in all, of them some science is taught, and in several there are to be found laboratories erected at a cost of many thousands of pounds. But the "modern side" does not rank high in the estimation of the public school, and science is dignified with the name of "stinks." Modern science seems to fit the English public school about as well as a new piece fits an old garment; and if a knowledge of science is a desirable and important thing in the upper classes of this country, the whole system of the public schools must be overhauled.

Prof. Perry himself says some plain words on this matter (p. 14):—

"Much of the evil we suffer from is due to our average young men being pitchforked into works where they get no instruction, as soon as they leave school. If ordinary school education were worth the name, and if schoolmasters can be brought to see that we do not live in the fifteenth century, if boys were really taught to think for themselves through common sense training in natural science, things would not be so bad. But the average boy leaves an English school with no power to think for himself, and with less than no knowledge of natural science, and he learns what is called mathematics in such a fashion that he hates the sight of a mathematical expression all his life after."

It is most true, as Prof. Perry said recently in a lecture to working men at South Kensington, that, under our present unscientific educational system, "the most prominent Englishmen understand nothing of those sciences which are transforming all the conditions of civilisation."

But it is sometimes said in reply to those who complain of the want of scientific knowledge and sympathy on the part of the heads of Government departments, "you must remember that the real managers of these departments are not the heads but the permanent subordinate officials." This may be so, but it is very doubtful if we are any better off in the hands of these permanent officials. The higher appointments of the Home Civil Service are now filled by candidates selected from those who have successfully passed the examination for the Indian Civil Service; and an investigation will show that about 80 per cent. of the successful candidates obtain their places by means of classics; thus the chances of an infusion of scientific thought into the Government offices are not great.

It is vain to say, as some of our politicians are fond of telling us, that England must depend for the encouragement of science upon private benefactions and not upon Government support; a Government which adopts such a principle is simply shirking one of the greatest of its obligations.

A striking illustration of the unsympathetic attitude of English Governments towards men of science, and more especially the teachers of science, is always furnished by a perusal of the "New Year" and "Birthday" list of honours. Peerages and baronetcies are given somewhat freely to brewers and political supporters, and a perfect shower of knighthoods and minor honours to a host of officials of whose achievements the nation in general is profoundly ignorant. Now and then a Kelvin, a Lister, or a Stokes appears; but, though England possesses scientific inventors and discoverers in large numbers, very few of them are thought worthy of national recognition.

Setting aside the radical weakness of our school system—its mediævalism—there are some defects that are more easily rectified; and among these Prof. Perry specially emphasises the orthodox procedure in the teaching of mathematics. Nothing but the ingrained conservatism of the English people would continue to base a boy's first knowledge of geometry on the peculiar language and the abstract reasoning of Euclid. Euclid, as has been repeatedly and vainly pointed out, was never written for boys; Euclid is difficult and not particularly well ordered; but Euclid is *classical*, and therefore Euclid is acceptable to the public schools, notwithstanding the fact that most boys waste years in attempting to acquire the somewhat grotesque language in which Euclidean logic is couched without attaining a real knowledge of even the nature of *an angle!* To know how Euclid shapes in the minds of the majority of schoolboys, to understand what a keen logical sense and expression they acquire from it by years of practice, one must conduct a public examination in the subject—and then not despair of the human race.

Prof. Perry does not confine his attack on our system of teaching mathematics to Euclid; he holds that a boy's scientific knowledge, generally, should not be primarily based upon abstract reasoning.

"Why not let a boy jump over all the Euclidean philosophy of geometry and assume even the 47th proposition to be true? Why not let him replace the second and fifth books of Euclid by a page of simple algebra . . . ?"

Some such procedure as Prof. Perry here indicates is really the key to improvement in our scientific teaching; and the objections which his proposal is likely to meet are met by him with a certain forcible humour:

"Because the embryo passes through all the stages of development of its ancestors, a boy in the nineteenth century must be taught according to all the systems ever in use and in the same order of time. Think of compelling emigrants to pass to America through Cuba, because Cuba was discovered first. Think of making boys learn Latin and Greek before they can write English, because Latin and Greek were the only languages in which there was a literature known to Englishmen 450 years ago!"

And this is, substantially, our procedure. Prof. Perry's remedy for our waste of time in mathematical teaching is contained in his advocacy of what he calls "Practical Mathematics," which may be described as a short cut to all the most important results and methods of science without the preliminary passage through a train of abstract reasoning in the old order—not, we presume, that the abstract reasoning is to be abolished altogether, but that it will come later and more easily when the results which it was originally employed to establish have become familiar practical truths by experience and measurement. This contention of Prof. Perry's does not, of course, agree with the pure *a priori* nature of mathematical reasoning hitherto accepted as orthodox truth. Indeed, it is not uncommon to hear even some scientific men objecting to such a principle as Prof. Perry's in some such terms as these: "Mathematics is primarily an education of the mind, and it must be regarded as an end in itself; the object of education is not the short and rapid attainment of practically useful knowledge, but the *cultivation of thought*." The simple answer to this is that, in view of the pressure of competition in the affairs of practical science, we cannot afford to take things in the old leisurely manner. Moreover, as already said, the re-ordering of our mathematical teaching according to the plan sketched by Prof. Perry in his chapter on "Practical Mathematics" does not involve, by any means, the *abolition* of abstract reasoning, but the *postponement* of it until the mind of the pupil is in the best condition to employ it.

We cannot afford space to discuss Prof. Perry's syllabus of practical mathematics in detail, but we may say that all those who have either the good fortune or the bad, according to the scene of their labours, to be employed in the teaching of mathematics, will find their work facilitated by adopting the system of graphic representation and graphic solutions so strongly advocated by Prof. Perry. The graphic method of solution of problems otherwise insoluble constitutes a wonderful interest both for the pupil and for the teacher; but, unfortunately, this fact is as yet very imperfectly recognised.

There is one branch of the question of school teaching which is scarcely noticed by Prof. Perry—the question of the preparatory school. The growth of the preparatory school in England within the last twenty years is most remarkable. This somewhat costly institution is, as a rule, an exact copy of the public school. The methods, the language, and, above all, the athletic ideals and aims of both are the same. The unscientific career in the greater institution is carefully initiated and cultivated in the less. Now, although nearly every branch of physical science is full of facts, principles and methods, the experimental illustration of which would awaken a far greater interest in the mind of a young boy than can be awakened by Greek or Latin grammar, the teaching of the elements of physical science in the preparatory stage of youth is almost unknown. There is a great deal of the elementary, but very important, portion of the science of electricity which every boy of the age of twelve (or less) should know, and could learn with no difficulty whatever; but he is kept rigorously aloof from all such knowledge, and we see him at the age of thirteen or fourteen fully equipped at his preparatory school for his public school exhibition or scholarship, absolutely ignorant of every electrical fact in existence.

This refers, of course, to boys of the better classes—those who look forward to a public school education. Prof. Perry remarks on the subject (p. 95):—

"I see no reason why the principles of physics should not be intimately known to every child who has passed the age of twelve years. . . . An examination of the work carried on in the model national schools in Ireland will show that in many cases children of eleven and twelve years possess a fair knowledge of physics and chemistry, and when they do not possess this knowledge it will be found that too much attention has been paid to Euclid and grammar, and perhaps practical geometry has not been studied at all."

In taking leave of Prof. Perry's suggestive little book, we would say that if the average English parent is content that his son should be brought up according to the classical model of the public school, with its athletic ideals and that superior "tone" with which it is generally credited, it might not be proper for any one to interfere with his choice; but when we reflect that these classical institutions are those in which our political rulers acquire their training and form their ideals, without appreciable modification by a subsequent career in an old University, the whole nation has a right to complain. The professional politician is apt to look down upon the professors of science; and until science makes its presence felt in the Government of the country by having eminent scientific men in its councils, we shall have to continue to deplore "England's neglect of science."

GEORGE M. MINCHIN.

GRANT DUFF'S NOTES FROM A DIARY.

Notes from a Diary, 1889–1891. By Sir Mountstuart E. Grant Duff. Vol. i. Pp. viii + 287. Vol. ii. Pp. 272. (London: Murray, 1901.) Price 18*s*.

IT might truly be said of Sir Mountstuart Grant Duff as was once said of Van Dyck, "During these years all noble England passed before him and remained immortal." He is a member of the best clubs—the

Athenæum, the Literary Society, The Club, &c.; he was for many years in the House of Commons, has been Under-Secretary for India, Under-Secretary for the Colonies, Governor of Madras, &c. He has thus had great opportunities, of which he has made the most. As was said of Archbishop Williams, he has "read the best, heard the best, conferred with the best; excribed, committed to memory, disputed; and had some work continually upon the loom."

Moreover, he has not only striven, and successfully, to know the ablest statesmen, literary men and men of science in our own country, but abroad also—V. Cousin, Hubner, B. de St. Hilaire, J. Simon, Taine, and many others were among his friends. The diary of such a man could not but be most interesting.

He has acted on the motto from Renan, which he places at the head of his first volume: "On ne doit jamais écrire que de ce qu'on aime. L'oubli et le silence sont la punition qu'on inflige à ce qu'on a trouvé laid ou commun dans la promenade à travers la vie."

Several of his reviewers have expressed the opinion that there are parts of the book which might have been spared, but I doubt whether they would have agreed which should be left out. The botany has been more than once suggested for omission; but to that I for one should, of course, demur. Sir Mountstuart has always loved natural history, and as a statesman has rendered valuable services to botany. He quotes with natural pleasure Sir J. Hooker's dedication to him of the 117th vol. of the *Botanical Magazine*, "as a slight acknowledgment of the valuable services which you rendered to botany and horticulture when Under-Secretary of State, first for India and then for the Colonies, and lately when Governor of the Madras Presidency; to which I would add, in memory of our long friendship, and our delightful rambles at home and abroad, in pursuit of our favourite science."

The whole book is full of good stories, of wise and witty sayings, of which, of course, we can only give a very small sample; for instance,

"—— is forty years old, Gladstone is eighty years young."

"Talleyrand remarks that 'Les affections lointaines sont un asile pour la pensée.'"

"Lady Alwyne Compton 'divided biography into autobiography, and ought—not to biography.'"

"Evarts, being asked if he was going to the funeral of a man whom he very much disliked, said, 'No, I shall not attend, but I quite approve of it.'"

"Woman was made after Man, and has been after him ever since."

"Two young ladies discussed for some time the colour of the Devil, when at last one said, 'I think you will *find* that I am right, dear.'"

"As Lady Blennerhassett left the dining-room she asked me, 'Do you like women's votes?' and supplied the answer, 'I like women who de-vote themselves.'"

"Mrs. Montgomery said of a friend, 'She gives me the impression of having been in the garden of Paradise before the Fall, but, having got a hint of what was about to happen, escaped before the coming of Original Sin.'"

While imbued with the scientific spirit, and thoroughly sympathising with the most liberal views of Stanley, Jowett and Renan, Sir Mountstuart Grant Duff has a deep feeling of reverence for the mysteries of existence. We meet again and again evidence of the profound impression made upon him by the récit d'une sœur; he speaks with affectionate veneration of Newman, and he tells us how much he valued the benediction which he sent him when he was starting for his Madras Government.

In his view of our religion he seems (though he does not expressly say so) to agree with Renan that

"Il ne sera remplacé que par un idéal supérieur; il est roi pour longtemps encore. Que dis-je? Sa beauté est éternelle, son règne n'aura pas de fin. L'Eglise a été dépassée, et s'est dépassée elle-même; le Christ n'a pas été dépassé."

The diary ends with an admirable address to the girls of the High School, Oxford. He gives them excellent advice: "Remember that to live a great and beautiful life is a far higher achievement than anything that can be done in life save by the very rarest genius."

He dwells first on what they should not learn—no higher arithmetic, no mathematics—no learning by heart, except some masterpieces, which should be kept up—no English grammar. Latin and Greek only as rewards.

Next what they should learn—reading, writing, drawing, book-keeping, needlework, cooking, enough French and German to read an ordinary book, some short treatise on logic, and enough music to enable them to enjoy the work of others, and some knowledge of the world in which we live. Lastly, he recommends them all to read four books—the "Meditations of Marcus Aurelius," the "De Imitatione," Gracian's "Oraculo Manual," and "Joubert's Pensées."

No one, I think, will put Sir Mountstuart's book down without a kindly feeling for the author, and a hope that he might have his characteristic wish to "come back every ten years, say for three weeks, just at this season, when the lilac, laburnum and wild hyacinth are out, to see how you are (the world is) getting on."

AVEBURY.

FIELD EXPERIMENTS ON WHEAT.

Cultura del Frumento, 1899-1900. *xiii Anno di cultura continua del Frumento e del Granturco.* By Prof. Italo Giglioli. Pp. xx+159. (Portici: Premiato Stab. Tipografico Vesuviano, 1901.)

IN the year 1887 Prof. Italo Giglioli, director of the R. Scuola Superiore Agraria di Portici, commenced a series of experiments on the growth of wheat under various manurial conditions at Suessola, in the Province of Caserta. The experiments are maintained by the Neapolitan Association of Landowners and Farmers, assisted, during the last few years, by grants from the Department of Agriculture.

The experimental field covers nearly two acres, and is divided by paths into 123 plots of about 45 square metres each. In most cases two or more plots (sometimes six or even twelve plots) receive the same treatment, and in this way the actual number of distinct experiments is reduced to forty-five. The produce of each of the 123 plots is, however, separately cut and weighed.

In the first year of the experiments wheat alone was grown, but owing to very favourable climatic conditions, and the character of the soil, it was subsequently found possible to grow two cereal crops each season—wheat from November to July and maize from July to October. The results show that the average yield of wheat is a good deal lower than in England, for instance; but the two crops taken together furnish an amount of grain in excess of the yields of the single crops obtained in England, Germany and the north of France. The character of the climate of Suessola is further illustrated by the fact that Rabi wheat from Oudh tends to give increased crops when grown in this district. English wheat, on the other hand, was found to deteriorate.

As regards the effect of the different manures on the wheat crop, horse-dung with sulphate of ammonia, applied in the spring, gave the highest yield, both of grain and straw. Sulphate of ammonia alone, applied in the spring, gave a higher yield of grain, but less straw than when applied partly in the autumn and partly in the spring; this result is attributed to the excessive rainfall during the winter months. With nitrate of soda there was a much lower yield of grain and rather less straw than with sulphate of ammonia. In accordance with what has been observed at Rothamsted and at Woburn, Giglioli obtained a greater weight per bushel under the influence of sulphate of ammonia than with nitrate of soda. Both these manures proved to be very effective when applied in conjunction with horse-dung. In this connection it may be mentioned that, quite recently, Hiltner has found that when humous sandy soil and heavy soil were inoculated with certain denitrifying organisms an increased production of oats was obtained. These results lend support to the view, now very generally accepted, that, in practice, the danger of any considerable loss of nitrogen under the influence of denitrifying organisms has been a good deal over-estimated.

Basic slag alone very considerably increased the yield of wheat grain; a still further increase in grain and also in straw was obtained when horse manure, or a mixture of sulphate of ammonia, nitrate of soda and potassium chloride were applied in addition to basic slag. Exclusively nitrogenous manures in addition to basic slag yielded about the same amount of grain, but more straw, than basic slag alone. Mineral superphosphate gave less satisfactory results than basic slag. Leucite, which occurs in large quantities in Italy, especially Roccamonfina, increased the yield of wheat when applied along with nitrate of soda; in conjunction with basic slag and nitrogenous manures, it produced about the same effect as potassium chloride under the same conditions.

Some interesting results are recorded on the effect of manganese dioxide, applied with various manures. These experiments, which have now been continued for three years, tend to show, in the majority of cases, that manganese dioxide in some way benefits the wheat crop. Further experiments on the subject, in which other crops, such as mangels, might be included, are desirable.

Electro-culture experiments with wheat manured with horse-dung showed a distinct gain both in grain and in straw when atmospheric electricity was employed, the increase in grain being relatively the greater. Voltaic electricity produced a still more marked effect, and increased the yield both of grain and straw by about 10 per cent.

It has not been possible within the limits of this short notice to give much more than a general indication of the lines of Prof. Giglioli's carefully conducted series of experiments, which, as time goes on, cannot fail to gain in interest and value. The present Report is well arranged for reference, and contains excellent bibliographies of some of the subjects investigated. The second Report, dealing with the results of the maize experiments, will, it is hoped, be ready before very long. N. H. J. M.

EARTH CURRENT MEASUREMENTS.

Die Erdströme im Deutschen Reichstelegraphengebiet und ihr zusammenhang mit den Erdmagnetischen Erscheinungen. By Dr. B. Weinstein. Pp. vi+78, and Atlas to ditto. (Brunswick: Friedrich Vieweg and Son, 1900.) Price, Mk. 4.

OF late years, when the interests of the electric railway and tramway have clashed with those of the observatories in which magnetic and earth current measurements are made, it has frequently been urged by the opponents of the observatories that they continue year after year accumulating data of which no use is ever made. Unfortunately, in most cases, owing, no doubt, to the very inadequate staff and multitudinous duties they have to perform, there is a certain amount of truth in this contention. It must, however, not be forgotten that the material is always available and can be worked up at any future date, while if the observations are interrupted, for however short a time, no amount of money or trouble expended at a subsequent time can replace the missing measurements. In this connection it is, therefore, with considerable pleasure that we welcome this pamphlet of nearly eighty pages, together with a quarto volume of curves, which give an account of the measurements made of the earth current curves obtained in two lines, one running between Berlin and Dresden, and the other between Berlin and Thorn during the epoch 1884–1888.

The author considers, in the first place, the manner in which the earth currents change, and in the second place to what extent these changes are connected with simultaneous changes in the terrestrial magnetic field.

In order to investigate the periodic changes in the earth currents, the ordinates of the photographic curves were measured for every hour and the means were used to calculate the coefficient of a Fourier expansion. The agreement between the values of the coefficients derived from the means for the various years is quite surprising considering the irregularity which one associates with all earth current phenomena.

The two lines being very nearly at right angles, and making the supposition that the current measured in the line is proportional to the current which traverses the earth, the author is able to calculate for each hour of the day the azimuth in which the current is flowing through the earth's crust. He compares the azimuth of this resultant current with the azimuth of the trace of the vertical plane passing through the sun. The results of these measurements, as well as a consideration of the way in which the earth currents change in magnitude and direction for the various months of the year, are all most clearly shown by means of vector diagrams. Vector diagrams are also given to show the changes in the earth's magnetic field for various stations, and a comparison between the two classes of curves shows a striking resemblance between their more salient features. It is quite impossible in such a notice as this to deal with the mass of data contained in the work, but we have no doubt that all interested in the fascinating subject of terrestrial magnetism will read the book with very great interest and feel, with the reviewer, that a great debt is due to Dr. Weinstein for the enormous amount of labour he has expended and for the satisfactory manner in which he has carried out his task.

OUR BOOK SHELF.

The Life of the Bee. By Maurice Maeterlinck. Translated by Alfred Sutro. Pp. 348. (London: George Allen, 1901.) 5*s*. net.

So far as our present knowledge extends, there are only four groups of animals which live in organised and more or less civilised communities at all resembling our own; and these are not mammals, or even vertebrates, as we might have been inclined to imagine *a priori*, but insects —ants, wasps, bees and termites. Hitherto entomologists have been inclined to award the palm of intelligence to the ants, but M. Maeterlinck thinks that the intelligence of the hive-bee has been somewhat underrated, at least as regards the readiness with which bees accept and adapt themselves to new conditions; and he also argues, as others have done before him, that the proceedings of human beings would probably appear far less intelligent to beings as far removed from man as man is from the bee, than do those of a bee-hive to ourselves. The book is not a romance in which bees are anthropomorphised, but an actual presentation of the life-history of the bee, and it appears to be abreast of the latest knowledge on the subject. The subject is discussed from the standpoint of a moderate agnosticism, and is interspersed with philosophical reflections on the various phases of bee-life as compared with human life, and of the equal mystery surrounding both. A fairly good list of some of the principal works on bees, in which English writers hold a very prominent position, is given at the end of the book. Incidentally, we are sorry to see the very unfavourable picture drawn, in § 94, of the peasantry of Normandy. We hope and believe that it is by no means universally applicable to the peasantry of other countries, including our own. As the work has doubtless been translated under the supervision of the author, it is probable that his meaning has been fairly grasped and expressed by his translator. As a specimen of the style of the book we may quote a short passage from pp. 302, 303: "Were an observer of a hundred and fifty times our height, and about seven hundred and fifty times our importance (these being the relations of stature and weight in which we stand to the humble honey-fly), one who knew not our language, and was endowed with senses totally different from our own; were such an one to have been studying us, he would recognise certain curious material transformations in the course of the last two-thirds of the century, but would be totally unable to form any conception of our moral, social, political, economic or religious problems." Here and there (as in the case of the word "importance" in the above passage) we find a word used which seems, from the context, hardly to express the author's meaning in English; and more rarely we find a technical error, as where *Sphinx Atropos* is once called a "butterfly" instead of a moth. These trifling defects can easily be remedied in a second edition, and in no way impair the interest of a book of somewhat unusual character. We should add that M. Maeterlinck is himself a practical bee-keeper (as well as an eminent man of literature), and has therefore the advantage of an acquaintance at first-hand with the general subject. W. F. K.

West African Studies. By Mary H. Kingsley. Second Edition, with Additional Chapters. Pp. xxxii + 507. (London: Macmillan and Co., Limited, 1901). Price 7*s*. 6*d*.

WE are glad that a popular edition of the late Miss Kingsley's "West African Studies" has been issued at a price which puts it within the reach of the humblest student; for, as we pointed out in our review of the first edition some twelve months ago, the book is worthy of the widest and closest study not only by students of primitive religion, but also by all those who have the interest of our West African colonies at heart. Before she started for South Africa Miss Kingsley had arranged to issue this edition, and though she did not live to see it through the press, the task of editing the volume has been completed by Mr. George Macmillan on the lines already approved by her. The new edition differs from the old by the omission of the appendices by the Comte de Cardi and Mr. John Harford, which, when once on record, are always accessible to the student, while their absence of general interest would have hardly justified their inclusion in the present reprint. In their place room has thus been found for a number of lectures and magazine articles which Miss Kingsley delivered and wrote shortly before her death. The new matter includes her Hibbert lecture on "African Law and Religion," some articles on "Property in West Africa," reprinted from the *Morning Post*, and two lectures on Imperialism in general and "Imperialism in West Africa." The bulk of the volume has been reprinted in its original form.

Mr. George Macmillan has prefixed an interesting introductory notice to the second edition, in the course of which he sketches the circumstances which led Miss Kingsley to undertake the researches which will always identify her name with West Africa; at the same time he gives a brief sketch of her character. We cannot refrain from quoting one passage, which seems to us to explain her personality more concisely and more truly than any other appreciation of her that we have yet seen.

"Not long after her death a friend who knew her well, a man qualified to speak by long experience of men and affairs, summed up the rare combination of overflowing sympathy and intellectual grasp which constituted at once the power and the charm of Mary Kingsley by saying that 'she had the brain of a man and the heart of a woman.' Speaking of her time in West Africa, she herself said, on one occasion, that she was 'doing odd jobs, and trying to understand things!' The phrase was characteristically modest, but here again we see how the heart which inspired the 'jobs,' which were always for some one else's benefit, worked deliberately in concert with the brain which was ever 'trying to understand things.' Together the two phrases strike the keynote of her life."

The Use of Words in Reasoning. By Alfred Sidgwick. Pp. xi + 370. (London: Adam and Charles Black 1901.) 7*s*. 6*d*. net.

THE name of Mr. Alfred Sidgwick is a sufficient guarantee that this book will be of value to all who are genuinely interested in the processes of reasoning, and desire, without plunging into the shadowy land where logic merges itself in metaphysical speculation, to extend their research somewhat further than a study of the formal logic of the schools will take them. The old-fashioned formal logic, "Pass Mods" logic, is, in fact, of little use except as a mental discipline for University passmen; others will hardly find in the ancient jingle of *Barbara Celarent Darii Ferioque prioris*, with its many combinations and permutations, a sufficient explanation of all the phenomena of reasoning. As Mr. Sidgwick says (p. 338): "Logic . . . might really quicken our sense of bad reasoning; but what formal logic does is only to quicken it in the least interesting and important direction, and so to draw our attention away from the serious dangers. In fact, we agree . . . that a man may improve his reasoning habits by studying logic, but we would lay rather more stress on the condition, 'if he has the sense to know when formalities are out of place.'" Mr. Sidgwick sketches the main points of his objections to the scholastic logic in a way which can be easily followed; and in his last chapter, on "How Logic might be Taught," he gives a succinct and simple explanation of the main processes which are employed in reasonable hinking.

Holidays in Eastern Counties. Edited by Percy Lindley. Pp. 96. (London: 30 Fleet Street, E.C.)

IT would be easy to select many places in which to spend a restful holiday from those described and attractively illustrated in this guide-book. The eastern counties possess many points of interest to students of nature and archæology, and are worth exploration in the days of leisure.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Vertical Light-beam through the Setting Sun.

THE not very frequently observed appearance of a vertical pillar of light through the sun when nearly setting was so very remarkably distinct and bright this evening as to deserve, perhaps, a particular description. I observed it in the Victoria Park, near Hackney, in the north-eastern part of London, from about 7h. 30m. to 8h. 10m. p.m. The setting sun at the first of those times was about 7° or 8° above the horizon, and its light was but little dimmed and tinged with yellow yet, by faint cirro-stratus cloud-bands among which it was shining, which ruled the western sky obliquely downwards towards a point of the horizon about 45° northwards from the sun. The light-column then, when I first saw it, was yellow coloured, bright and narrow at the base, but more diffused above, where it could be traced up to a length of 5° or 6°, while its base rested upon, or extended very little, if at all, below the sun. The summit grew narrower and higher as the sun descended lower, while the base became brighter and followed the sun down until, at about ten or fifteen minutes to 8, the sun was much dulled in light and assumed an orange yellow colour in entering a bank of haze about 5° from the horizon. Below that altitude the light-column's base never descended; but when at about 8 p.m. the sun had acquired the magnificent appearance of a great crimson disc, still about 2°, or some four of its diameters, clear from the level park horizon, the tall column shone beautifully above it as a perfectly straight, vertical, narrow streak of light about the sun's apparent diameter in width and 8° or 10° in length (from about altitude 5° to altitude 15°, and very faintly rather higher), bright yellow at its base, but becoming insensibly whiter and dimmer, without lateral diffusion till lost across the faint cloud-streaks which seemed here and there just visibly to lengthen it and very faintly extend it somewhat higher. It shortened gradually, and died out at last about 8h. 10m. p.m., soon after the sun itself vanished in the haze before reaching the horizon, but without changing the altitude, about 5°, of its base; and it retained to the last the straight, vertical appearance of which many of the vast number of people enjoying the fine evening in the extensive park were admiring watchers. I noticed no horizontal belt of light through the sun, nor mock-suns at their usual distances on its right and left hands, where the bands of cirro-stratus yet extended far enough to have given rise to them if they had consisted of cloud-materials of a fit and suitable description to produce them; and nothing very notable, except the vertical light-beam across the streaky clouds and the sun's intensely red-coloured orb below it, seemed to be of very marked meteorological significance in the beautiful display.

It seems hardly doubtful that the vertical light-beam must proceed in some way from passage of the sun's nearly level rays through horizontal refracting surfaces, such as those, for example, of thin, flat, hexagonal snow-crystals. A natural tendency which such floating crystals and collections of them into flat snow-flakes possess, in fact, of remaining horizontal while falling through perfectly still air, as flat leaves of paper, especially symmetrically shaped ones, if started horizontal on their journeys also may be seen to do,[1] affords fair grounds for an assumption that the sun's slightly sloping rays are really dispersed into these observed vertical light-beams by passing through the horizontal faces of such thin, flat, floating crystals. In what further way the light is spread upwards and downwards in passing through the thin transparent plates seems, indeed, to be a rather more doubtful subject of conjecture; but either want of perfect parallelism of the plates' flat surfaces, perhaps through partial melting, or refractions through the thin plates' bounding faces which give them chisel-edges, supposing these edges to be also slightly rounded off by partial melting, would certainly suffice, in the large proportion of a snow-cloud's floating crystals which optical considerations show must always be suitably oriented to produce refractions of the sun's rays upwards or downwards in directions either vertical or as nearly vertical as possible, to account for the columnar light-beam's well-defined extension in a vertical direction. Yet for better insight into its origin and surer proofs of the correctness of its theoretical explanation, fresh attention to the features and meteorological circumstances of the beam's display when it is well developed would certainly be desirable, and of great value to increase and improve our knowledge of this rather rare and singular form of halo, or occasional form of cloud illumination by the sun and moon. A light north-west wind was blowing on the ground, and the sky seemed to be dimmed by the faint streaks of cirro-stratus only in that quarter of the horizon where the slender beam of yellow light was visible; but the air might easily be quite calm and motionless aloft, in that thinly clouded region of its very high upper strata. A. S. HERSCHEL.

Observatory House, Slough, June 26.

A New Method of using Tuning-forks in Chronographic Measurements.

THE tuning-fork, when used for making time traces in chronographic work, is usually made to vibrate, by bowing with a violin bow, or by percussion, or by rapidly removing a metal block from between the two prongs, or by an electro-magnet the circuit of which is interrupted by the fork itself. When many details have to be attended to in an experiment, the first-mentioned methods are inconvenient, and the last one, namely the electrical, is not without an element of error. In order to obtain the convenience of the electrical method without introducing the error due to the electrical driving of the fork, two forks of the same period are used; the fork which makes the trace is furnished with an electromagnet, but no contact-breaker, the current being controlled by the second fork, which has a contact-breaker. This method of driving a chronographic fork is well known. My new way of using this combination is to cause the chronograph, during the short period during which the records are made, to cut out entirely the electrical circuit from the fork used to make the time trace and to close the circuit again immediately after the records are made. By this means the recording fork is not hampered with a contact-breaker, nor is it subject to the influence due to the electro-magnet, while its trace is being made on the moving surface of the chronograph. After the time trace is made, the circuit is again established, so that the vibration is maintained, and the fork is ready for the next experiment.

Trinity College, Oxford, June 28. F. J. JERVIS-SMITH.

Long-tailed Japanese Fowls.

WITH reference to Mr. J. T. Cunningham's letter on these birds in NATURE of June 13, I should like to be allowed to point out that the very interesting evidence he gives is yet not sufficient to prove his point. The words of his correspondent do not necessarily imply that he had personally witnessed the manipulation part of the process adopted to secure extreme length of

[1] This is a rather surprising experiment to those who may have been accustomed, as I have always been used hitherto, to see paper clippings, when tossed up at random, pirouette like little windmills or teetotums in falling through the air. But held by a corner for a moment, out of air-draughts, horizontal, if the hand's support is withdrawn quickly, letting them go at the same time without any impulse, squares, circles, hexagons, or other small cuttings of flat paper will all be found to fall to the ground from any height with very little oscillation, or even sometimes remaining throughout their fall quite horizontal.

feather; and the practices of keeping the birds on perches and of tying up their tails were already known. Such manipulation as is described would be extremely likely to result in the pulling out of the feathers concerned altogether, for all fanciers are well aware that a growing feather is only too easily extracted or knocked out, often to their disappointment.

Moreover, manipulation of the *tail*-feathers, even if it be really practised with the result described, would not account for the likewise abnormal elongation of the saddle-feathers or rump-hackles, or for the fact that the tail-feathers and tail-coverts of the hens of this breed are also slightly elongated, as may be seen in the Natural History Museum specimen.

That a breed of ornamental poultry with the hackles and tail-feathers abnormally elongated could be produced by continual selection of variations in the right direction no breeder would doubt, and so the living specimens of long-tailed fowls one sees in Europe present no special difficulty. Indeed, even the goose, a bird, as Darwin remarked, of singularly inflexible organisation, has produced a breed with abnormally lengthened plumage—the well-known Sebastopol goose.

The difficulty mentioned by Mr. Cunningham, that European specimens of the long-tailed fowls do not approach the length of feather seen in Japanese examples, is undoubtedly a real one. But a simpler explanation than the very unlikely one given by that gentleman would be that the true long-tailed breed is the offspring of a "sport" endowed with more or less continuously-growing feathers, analogous to the rootless teeth occurring in so many mammals, and that the European specimens fail to produce such feathers either on account of a different environment, which is known to have an influence on the growth of feathers, or because they are not good examples of the breed.

It may be objected that continuously-growing feathers are not known to exist in wild birds; but neither do we find in these the duplicated hallux, or the very heavy feathering of the feet, both of which points occur in domestic fowls, and the last in pigeons also.

As to the inheritance of acquired characters, the annals of the poultry fancy furnish no evidence of this, so far as I am aware, nor do they encourage a belief in the theory that the naked head-appendages of the fowl, and its long hackles, are due to stimulation caused by fighting. For the most pugnacious of all breeds, the Aseel of India, has the comb and wattles almost rudimentary, and the hackles, like the rest of the plumage, unusually short and scanty. The same remark applies to the allied Malay or Chittagong breed, while the old English fighting game was hardly modified from the jungle-fowl, and certainly has not a large comb. On the other hand, the large-combed breeds of the Spanish type are not particularly pugilistic, and the size of their head-appendages is recognised by fanciers to be due to selection. So much for the supposed effects of stimulation on living structures.

It may not be irrelevant here to mention a case of manipulation by oriental fanciers which recently came under my notice in India. I had observed some red or chestnut-coloured pigeons with white bars on the wing, and asked my friend Mr. W. Rutledge, who has been a dealer and fancier for nearly half a century, to what breed these birds belonged. He replied that they were of no breed, but that the marking in question was produced by plucking out the feathers constituting the bars three times, when they would be produced white, as I had seen them. But, he added, the birds would not breed young resembling them in this point. I have thought this instance worth recording as illustrating the lengths to which some Eastern bird-fanciers will go, and as showing that experienced men are well aware that acquired characters are not inherited. FRANK FINN.

c/o Zoological Society, 3, Hanover Square, London.

Decomposition of Copper Oxide.

IN the course of some recent experiments which involved the heating of copper wires in vacuo to temperatures of 1000° or 1050°, several facts were noticed which seem to me worthy of record and of further investigation.

The wires in question were heated in a porcelain tube 12 inches long, the lowest quarter of which was at a uniform temperature, the maximum, while above this the temperature gradually fell off till it reached that of the room.

It was noticed that whenever the vacuum had not been as good as usual the consequent oxidation of the copper in the hot end of the tube did not extend over the whole length of heated wire, but that $\frac{3}{4}$ inch or so of wire was perfectly bright, with considerable oxidation both above and below the bright region.

The temperature of that part of the wire at which brightness occurred was about 950° C. At first sight it appears from this that copper oxide, probably the black variety, decomposes somewhere in the neighbourhood of 950°, but recombines again at a higher temperature.

Another possibility is that the change is connected with the formation of the red oxide, though the appearance of the bright portions of the wires does not favour this idea.

Volatilisation of the metal itself appears to go on at the bright parts, but it is difficult to account for the observed phenomena on an hypothesis of volatilisation alone.

University College, London. PHILIP HARRISON.

The Subjective Lowering of Pitch.

As a question arising out of Mr. Harding's letter (p. 103), it would be interesting to know what is the effect produced by sounding a note loud enough to produce the subjective distortion, while at the same time the note to which it appears to be flattened is sounded more quietly. I suppose discord would be inevitable, but possibly a musical ear would be able to judge whether subjective distortion was prevented in the loud, or produced in the softer, note.

Mr. Allen's argument (p. 182) may, I think, be disposed of in the following manner. He states that the singer should be conscious of flatness. Now if he is singing with an instrument, the note he sings is the only one he can possibly sing without being conscious of discord. If he sings so much higher that his distorted note is depressed till it sounds (in the absence of the instrument) as though it were the correct note, he produces discord with the instrument. His only course is to sing the note of the instrument, reinforce it, and so unconsciously cause the subjective depression of both. I am writing in ignorance of whether the effect is observed in unaccompanied singing and solos on the violin. E. C. SHERWOOD.

St. Peter's College, Westminster.

A Curious Phenomenon.

A CURIOUS phenomenon occurred to some volunteers while on outpost duty on the Delagoa Bay Railway in the Transvaal.

A search-light was fixed up in the station, which was used nightly in scanning the wide stretches of veldt. We were on solitary outpost duty about three miles from the station, and on the still silent nights which are frequently experienced in the clear atmosphere of the high veldt we distinctly heard a low "purring" sound as the ray of light of the station passed over us. As the light approached us one could hear the sound gradually increasing, being loudest as it switched over us and passing away into the nothingness of the silent night. We were too far off the station to hear any vibrations from the mechanism of the search-light, and we all came to the conclusion (being a collection of unscientific men) that the high velocity of the light waves created a sound audible to our ears. On other nights when there was only a slight breeze no noise could be detected.

Can any one of NATURE'S readers tell me if this is a known physiological effect? STANLEY B. HUTT.

Broxbourne, June 20.

THE ANTARCTIC EXPEDITION.

THE instructions to the commander of the National Antarctic Expedition—*verbosa et grandis epistola*—have now been published, together with a similar document, of much greater brevity, addressed to the director of the civilian scientific staff. Most of the former, much even of the latter, would not interest our readers, so we print only a few extracts relating more immediately to the matters recently under discussion. We take first (though not in order) the following clause:—

The *Discovery* is not one of His Majesty's ships, but is registered under the Merchant Shipping Act, 1894, and is governed by it. Copies of this Act will be supplied to you. You will see that the officers and crew sign the ship's articles as required by the Act. The scientific staff will not sign articles, but are to be treated as cabin passengers. You must be careful not to take more than twelve persons as passengers.

So it is now quite clear that the *Discovery* is not on His Majesty's service in any sense of this phrase; the demand also that the members of the civilian staff should sign articles has been dropped as impracticable; so we fail to see why an officer of the Royal Navy without any experience of Polar exploration should have been preferred for the command to a captain in the merchant service familiar with work of this character and less likely to stand upon the dignity of his rank.

We observe also that the civilian director is carefully warned off from interference with all scientific work done by the officers of the ship by the following clause:—

The scientific work of the executive officers of the ship will be under your immediate control, and will include magnetic and meteorological observations, astronomical observations, surveying and charting, and sounding operations.

We may remark that, throughout, the instructions indicate that the framers of them are not quite easy in their minds, for it is solemnly impressed on the commander that he has a grand chance which he must on no account throw away, and advice is given to both which might be put in the homely form, "We hope you will be good boys and not quarrel."

We pass on to the definitions of the objects of the expedition:—

The objects of the expedition are (*a*) to determine, as far as possible, the nature, condition and extent of that portion of the South Polar lands which is included in the scope of your expedition; and (*b*) to make a magnetic survey in the southern regions to the south of the 40th parallel, and to carry on meteorological, oceanographic, geological, biological and physical investigations and researches. Neither of these objects is to be sacrificed to the other.

Geographical discovery and scientific exploration by sea and land should be conducted in two quadrants of the four into which the Antarctic regions are divided for convenience of reference, namely the Victoria and Ross Quadrants. It is desired that the extent of land should be ascertained by following the coast lines, that the depth and nature of the ice-cap should be investigated, as well as the nature of the volcanic region, of the mountain ranges, and especially of any fossiliferous rocks.

Whenever it is possible, while at sea, deep-sea sounding should be taken with serial temperatures, and samples of sea-water at various depths are to be obtained for physical and chemical analysis. Dredging operations are to be carried on as frequently as possible, and all opportunities are to be taken for making biological and geological collections.

Whether the *Discovery* should or should not winter in the ice is left to the discretion of the commander. In that event the following direction is given:—

Your efforts, as regards geographical exploration, should be directed, with the help of depôts, to three objects, namely, an advance into the western mountains, an advance to the south, and the exploration of the volcanic region.

And it is kindly added:—

The director and his staff shall be allowed all facilities for the prosecution of their researches.

In the event of not wintering, the commander is instructed to land a party between Cape Crozier and Cape Johnson, if a suitable place can be found. In regard to magnetic observations special directions are given, from which it appears that the authors of the instructions have taken pains that at any rate this branch of science shall not be neglected.

The instructions to the director of the civilian scientific staff cannot be said to err on the side of precision. For information as to the objects of the expedition they refer him to the instructions given to its commander, which, it is said, will also suffice to indicate his position relatively to the latter. The director can certainly claim to be unfettered as to his methods and objects of work, for there is no direct mention of anything but the disposal of the results. It might, however, have been well for those responsible for these instructions to have indicated the points on which information was especially desired. Still, they have not omitted the precaution of informing the director and members of the civilian staff that they join the expedition at their own risk.

But who is this director? The instructions name two officials, Mr. Hodgson (biologist), Mr. Shackleton (physicist), and the two medical officers, Dr. Koettlitz and Dr. Wilson, who will act respectively as botanist and zoologist when their other duties permit. We are aware that Mr. George Murray will occupy he position of director at the outset of the expedition, but it has been publicly stated that he will not accompany it beyond Australia or New Zealand. Is he to devote himself during his voyage out to training up one of these four in the way that he should afterwards go as his successor, trusting, as with a plant, to quick development under the tropical sun? or is there still a lingering hope of picking up a director somewhere in the Antipodes?—that would indeed be a feat worthy of the *Discovery*!

Magnetic work, as we have said, is happily not neglected. Biological work also, so far as it can be done from the ship, will probably receive attention; how far it will be carried out on land must be left, as we have seen, to the chapter of accidents. Geology has to be content with a bare mention, and the Antarctic ice is just named. Yet a thorough study of its phenomena should have been made prominent among the objects of this expedition. The ice cap of the Antarctic region, as has long been known, is in all probability on a much grander scale than even in Greenland. It is as large as, if not larger than, any which existed in northern latitudes during the glacial epoch. Here, then, if anywhere, information can be obtained as to the work and the indications of such an ice-cap. Certainly these questions will not be solved, nor "the depth and nature of the ice-cap" investigated, by following the coast-line or by anything less than by the researches of a party stationed for a considerable time on the land. But to make information on these questions really valuable it must have been collected by one who is thoroughly familiar with them and can distinguish between trivial and important phenomena. Can we say that any member of the staff possesses these qualifications? Indeed, as we see from the description quoted above, no one of the present staff even claims to be a geologist.

One other point deserves notice. In a covering letter, signed by the chairman of the final committee of the Royal and Geographical Societies, sent with the instructions to their presidents (to which, as it is not marked confidential, we presume we may refer), we find a statement that the instructions have been settled in their present form in consequence of Prof. Gregory's resignation. The reason for bringing in his name is not easy to discover, unless it be that the committee felt ill at ease; for it is a wise policy, when conscious of being in a very questionable position, to hint to all the world that the other party is to blame. Any such innuendo Prof. Gregory can afford to disregard. His actions have been throughout above board and consistent. The Royal Society, as we have already pointed out, has displayed, through its representatives, little care for the interests of science and a lack of moral courage in fighting its battles. We can now only hope for the best; but we fear events will prove that these things also are better managed in Germany than in England.

THE SIMPLON TUNNEL.

FEW undertakings have had to encounter so many difficulties as those which have impeded the construction of the Simplon Tunnel. Apart from the purely mechanical scheme which proposed to cut a narrow space in a definite direction through hard rock for a distance of some 20,000 metres, at a considerable depth below the surface, and the difficulties of a physical character connected with temperature and sanitation, there must be added financial considerations of a very onerous character, possibly increased by the subtle and continuous opposition on the part of existing interests. That all difficulties, save, of course, the actual labour of tunnelling, have gradually disappeared speaks eloquently of the energy and mechanical resource displayed by the engineers, and of the policy and address exhibited by the management. Rumours have appeared now and again in the newspapers of strikes among the workmen and of delays arising from that source; but such inconveniences have always to be anticipated in long-continued workings owing to the gradual changes that occur in the condition of labour. Such annoyances may delay the completion, but they cannot prevent it.

We commented on some of the difficulties and some of the advantages attendant on the construction of the tunnel in a previous article on April 20, 1897, when the project had entered on the stage of a practical undertaking. Four years having passed since that time, it is not uninteresting to review the progress that has been made, and see how far the ingenuity of the engineers has triumphed and what prospect there is of a completion within the term originally assigned. The contract for the construction of the tunnel was signed by Messrs. Brandt, Brandau and Co. on August 13, 1898, but this firm stipulated for three months' grace before boring operations should commence. Consequently, November 13 is the date from which the five and a half years demanded for the construction of the tunnel is to be reckoned, and the critical epoch will be May 13, 1904, when a fine of 5000 francs a day will be demanded from the firm for the non-fulfilment of the contract, or a reward of similar amount be paid to them for the earlier completion. Practically, 2000 days have been assumed as sufficient to bore through 19,734 m. of rock, consequently the average daily progress should be 9·86 m. Of course, this perforation applies to the distance traversed at both ends, because the work really consists in making two tunnels of approximately equal length, whose ends shall join in the middle of the mountain. From data supplied in an article by Herr L. Ernst in *Die Umschau* for April 13, it is easy to compare the actual advance made at either end with the daily average that the contractors hoped to make. The attack on the north side was begun on November 22, 1898, and at first the boring machines encountered a tolerably soft stone, and the progress was proportionately rapid, attaining a daily maximum of 6·5 metres. But on reaching the gneiss, of which the general mass of the mountain is composed, the workmen had to content themselves with a daily average of 5·28 metres. But on January 1, 1901, or 769 days after commencing operations, a tunnel of 4119 metres actually existed, and this gives an average advance of 5·4 metres daily. On the south side, owing to some difficulties with the Italian Government, who objected to the employment of dynamite for blasting operations, the boring machines did not get to work till December 24. Further, a much harder stone had to be penetrated on the southern side, and the daily progress was only 3·71 m.; but the employment of more efficient water power has raised this slow advance to 4·5 m. Effectually, a tunnel of 3148 m. had been bored by January 1; and this gives an average progress of 4·3 m. Clearly, therefore, the daily advance at the two ends is slightly behind the anticipated amount by 0·26 m., but by the removal of initial difficulties and greater experience on the part of the management, this slight deficit may be wiped out.

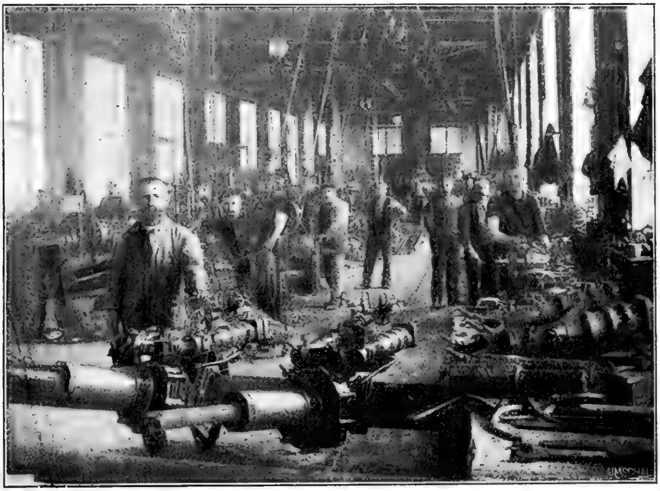


FIG. 1.—Workshop in Brieg, Switzerland, at the foot of the road leading over the Simplon Pass. In the foreground are two boring chisels mounted on one stand. (From *Die Umschau*.)

Very considerable modifications have been introduced in the form and manner of working of the boring machines. In the earlier constructed tunnels the boring chisels, faced with diamond, cut their way into the rock, the motive power being compressed air, the compression being effected by hydraulic machinery. Herr Brandt recognised the loss of mechanical power in this arrangement, and decided to use water pressure direct on the boring apparatus. At the same time he dispensed with the diamond cutting process, which, by means of rapid rotation, worked its way into the stone as a saw, substituting a hard steel face to the chisel, which is driven against the rock and rotates slowly, about six times a minute. The boring tool is made hollow, and the detached fragments collect in the tube and are expelled by water power. Two boring chisels are mounted on each stand and are worked simultaneously (Fig. 1). The aperture of each borer is 10 cm., and is driven into the rock a distance of 2 m. Into the aperture thus formed a cartridge of dynamite is placed and exploded, the rock shattered by blasting has to be removed, and the borer is then pushed forward and the operation continued. On the northern side this cycle of boring, blasting and removal is effected in about seven hours, on the southern side in about an hour less, more time being required to remove the *débris* on the north than on the south. The transport of the masses of rock detached by the blasting is necessarily a work of enormous labour, and compels the boring machine to be idle while it is effected. Herr Brandt designed a machine to accelerate the removal of the rubbish by making it slide along smooth iron plates arranged to receive it. But the application has not proved so useful as was anticipated, and its employment is at present abandoned.

In the explosion of the blasting charge, liquid air or oxygen has been used with good effect. The charcoal covering of the charge is, shortly before use, steeped in liquid oxygen, and the recovery of the gaseous form has the advantage of mitigating some of the evils the presence of carbonic oxide tends to produce. But improvements in this process are still demanded, and experiments are being carried on by Prof. Linde, of Munich, with a view to making the combustion more perfect and removing some of the noxious vapours due to blasting.

We gather that the attempts made to lower the temperature in the cutting have not proved quite as successful as was anticipated. As mentioned in our former article, it was proposed to effect the necessary cooling by the distribution throughout the workings of a water dust under considerable pressure. In pursuance of this plan some 70 litres of water per second, and under a pressure of 100 atmospheres, are scattered throughout the gallery by means of machines placed in the crossway alleys that lead from the main boring to the parallel gallery. Such a liberal expenditure of water has been found sufficient to enable miners to continue working at depths where the ordinary temperature is greater than has been encountered in the Simplon. But Herr Ernst is not yet satisfied; he says that the temperature question is still unsolved, and gives the following figures for comparison with the Gotthard workings.

	Temp. at 7·3 km. from north entrance.	Temp. at 7·05 km. from south entrance.
April and May, 1880 ...	30·46 C. ...	30·53 C.
June, 1882 (after perforation) ...	23·73 C. ...	23·39 C.
July, 1883	22·20 C. ...	23·1 C.

But in the Simplon, at only 1400 metres from the southern entrance, a temperature of 30° C. has been experienced, while the water of a spring near that point showed a temperature of 33° C. Fortunately, the water supply is adequate and easily accessible whether on the north or south side. On the north the Rhone feeds a reservoir formed 44 m. above the tunnel entrance at the rate of 6000–8000 litres per hour. At the southern end, near Isella, the Diveria is equally available, and from both sources it is estimated that the undertaking has at hand the equivalent of 2000 h.p., sufficient for the driving of the pressure-pumps and boring machinery, the ventilation of the shaft, the mechanical workshops, the electric illumination and numerous experimental works.

Recalling the carelessness of life and enervating sickness that decimated the workpeople in the case of the Gotthard tunnel, it is refreshing to notice the care and attention that are bestowed on the comforts of the operators in this instance. Provision is made for frequent baths, and changes of clothes are insisted upon, the maintenance of a simple system ensuring regularity and obedience. A school and hospital, not to mention a theatre, are provided for the use of the workpeople, and hostelries are erected wherein the meals are arranged at fixed and certainly very low prices. A regular meal of soup, meat and vegetables costs but ·50 cents, the full ration for the day being 1·10 francs. The daily wage does not seem large at 3 or 4 francs, but apparently is sufficiently attractive, and we are assured that the careful wage earner can send a modest contribution to his relatives every month. A whole colony has settled down under the shadow of the Simplon, but the man whose genius has called into being this hive of workers, whose activity has encouraged and animated the whole undertaking, whose resourceful energy has overborne so many difficulties, is no longer at the fore to guard against future dangers and to guide the whole to a successful issue. Herr Brandt died in November 1899, when progress was slow but assured. He has, however, left four able lieutenants, who, trained in his school and possessed of not less devotion and energy, will carry through the arduous work and permit us to see yet another and the longest tunnel under the Alps pushed to a successful termination.

NOTES.

PROF. E. VAN BENEDEN, professor of zoology and comparative anatomy in the University of Liège, has been elected a correspondant of the Paris Academy of Sciences in succession to the late Sir William Flower.

THE next meeting of the American Association for the Advancement of Science will be held in Denver, Colorado, on August 24–31. The membership of the Association is now larger than it ever was before, more than eight hundred new members having been elected within the past year. As already mentioned, it is proposed to hold a winter meeting each year in the week in which New Year's day falls, and the summer meeting may eventually be omitted altogether. Of the fourteen universities forming the Association of American Universities, twelve already do not open their terms until after the week in which New Year's day occurs, or have arranged not to do so, and it is expected that the remaining two will come to the same decision. A convocation week will thus be set aside for the annual meetings of scientific and learned societies, and the difficulty of getting men of science together during the summer holidays will be avoided.

A NEW magnetic observatory is being established just now in France. It is situated at a distance of only thirty miles from Parc St. Maur, where records have been rendered impossible, electrical railways using the earth for return currents having been laid in almost every direction. The new observatory is situated in the small parish of Villepreux, in] a district occupied by farms, cornfields and woods. The authorisation was granted by the Government only when the railway companies had paid to the National Treasury a sum of 1200*l*., sufficient for paying all the expenses of the new building. These have been greatly diminished because the land covers about ten acres belonging to the Government, and some old buildings without any artistic value can be demolished for procuring the stones required in order to construct the magnetic pavilions and a house for the observer. M. Moureau will continue to reside at Parc St. Maur, and the new observatory will be considered as an accessory to the old one.

THE importance of the scientific study of Africa and its native inhabitants has often been urged in these columns. We notice, therefore, with much satisfaction that the African Society has been formed with the object of enlarging and extending the work done by the late Miss Mary Kingsley, so s to include the whole of Africa in the field of operations. The Society will thus not only commemorate the name and continue the investigations of Miss Kingsley, but should lead to the organised investigation of the native races of Africa, the natural history, resources, diseases and other subjects upon which exact knowledge is required. In Germany the publication of a journal, as well as of some books dealing with many of these subjects, has already been inaugurated under the auspices of the Government. In France an independent society, more on the lines of what is now proposed, is at work in French Africa, and other European nations are advancing in the same direction. England ought not to be behind in this work, and the new society will do good service by encouraging interest in its objects. At the meeting held on Friday last, when the first meeting of the Society was held, the Marquis of Ripon, who occupied the chair as president, pointed out the need for scientific research in Africa. In order to discharge the responsibilities of Empire it is essential, he remarked, to set to work to understand the full and complete nature of the problems with which we had to deal, to study the whole field of African affairs, and, above all, to endeavour to understand, so far as might be possible, the thoughts, the views, the opinions and laws of the people. It is only by this means that we can arrive at a state of things in which our administration is likely to be successful. The secretary of the Society is Mr. R. Sewell, 22, Albemarle Street, London, W., to which address all communications should be sent.

THERE is no doubt that the establishment of an experimental tank in which models of ships could be tested for resistance, form, stability and other qualities would benefit the science of naval architecture in this country. The subject was brought before the meeting of the Institution of Naval Architects at Glasgow last week, and received much support. Dr. Elgar directed attention to this question in describing how the Government tank at Washington was available for the use of private shipbuilders on the payment of a fee merely covering expenses. Mr. A. F. Yarrow, referring to this statement, pointed out that the British Admiralty had an experimental tank of their own at Haslar, near Portsmouth. There was one other tank in this country, which was owned by a private shipbuilding firm. Mr. Yarrow submitted that, having in view the rapid increase in competition in shipbuilding, it was desirable that no stone should be left unturned by the shipbuilders in this country to keep well to the front, and that all the means modern knowledge could give should be made available for ship designers. He therefore proposed that the Institution of Naval Architects should take into consideration whether such a tank should not be established under its auspices, so that it might be available, not only for shipbuilders in this country and members of the Institution, but also for all willing to pay for the information to be obtained, irrespective of nationality. Sir Nathaniel Barnaby referred to the immense benefit that had accrued to the science and practice of naval architecture by the investigations of the late Mr. Froude, which he had carried out by means of the experimental tank he ad originated, and by means of which various qualities of different forms of ship could be determined with models of practicable size. At the present time all types of British war vessels were tried in this way. The resolution suggested by Mr. Yarrow was to the following effect:—"That this meeting, having regard to the desirability of establishing a tank in this country for testing the resistance of models, and which might be available for all shipbuilders, request the council of the Institution to take the matter into serious consideration with a view to arriving at the best means of carrying out the suggestion." This was put as a motion by Lord Brassey and seconded by Sir Nathaniel Barnaby, and carried with acclamation.

DURING the past few days exceptionally high temperature conditions have prevailed in New York and the neighbourhood, and have resulted in numerous deaths from heat apoplexy. On Monday shade temperatures from 103° Fahr. to 111° Fahr. were recorded, and the official reading was 98° Fahr. The minimum night temperature was 87° Fahr.

THE Berlin correspondent of the *Times* announces the death of Prof. Johannes Lamp, one of the scientific members of the expedition which was charged with the demarcation of the boundary between German East Africa and the Congo State in the neighbourhood of Lake Kivu. Prof. Lamp, who was born at Kiel, was for some time employed at the Geodetic Institute in Berlin. He was afterwards appointed to the observatory at Kiel, and held a professorship at the University of that city.

WE learn from the *British Medical Journal* that a bust of Dr. Armauer Hansen, the discoverer of the bacillus of leprosy, will be unveiled with appropriate rites in the Lungegaards-Hospital at Bergen on August 10. In order to give the ceremony as much of an international character as possible, an invitation has been issued to prominent members of the medical profession throughout the world by Prof. Rudolf Virchow, president of the committee. Gerhard Henrik Armauer Hansen was born at Bergen in Norway in 1841, and has spent the whole of his professional life in that town, where he was for many years on the staff of the Lungegaards-Hospital.

IT is stated by the *Engineer* that the General Electric Company of Berlin has just completed near Naples, in the valley of Pompeii, an installation for the transmission of electric energy, all the conductors used being of aluminium. This installation comprises three horizontal turbines of 150 horse-power, working at 190 revolutions per minute. These turbines each drive a tri-phase alternator, and the current, at a tension of 3600 volts, is led along three aluminium lines to Pompeii, Sarno and Torre Annunziata. The first of these lines, which has a length of about 3 kilometres, leads to a substation comprised of two three-phase transformers of 45 kilowatts. The second line, which leads to Sarno, has a length of 15 kilometres; it conducts the current to a tri-phase motor working at 3500 volts, and driving a continuous-current dynamo of 36 kilowatts capacity. This installation supplies a three-wire system at a tension of 240 volts. Finally, the line to Torre Annunziata has a length of 3·5 kilometres, the current serving for motive power in the macaroni factories in the district.

IN an interesting and useful supplement to the Daily Weather Report, the Meteorological Council have published values for pressure, temperature, rainfall and bright sunshine for each month of the year. The sunshine values refer to a period of twenty years, temperature and pressure thirty years, and rainfall thirty-five years, all ending with the year 1900. With regard to temperature, a glance at the tables shows when the highest maxima of the period occurred. The maxima in London were: 96° (August 1876), 91° (June 1878), 95° (July 1881), and 91° (September 1898). The coldest winters occurred in 1881 and 1895, the lowest readings in London being respectively 9° (January) and 10° (February). Much lower readings were registered in other parts of England and in Scotland.

WE have received the Report of the director of the Liverpool Observatory, Bidston, containing the result of the astronomical and meteorological observations taken in the year 1900. The work of this Observatory dates back to the year 1845, and the observations, which are taken with every care, form a very valuable contribution to our knowledge of those sciences. The transit instrument has been used continuously for the determination of time and continues to give entire satisfaction, and the self-recording meteorological instruments have worked without failure the whole of the year. A Milne seismometer, provided by the Earthquake Committee of the British Association, has recently been added to the existing apparatus. As in former years, a useful comparison has been made between the records of Osler's and Dines' anemometers, and the results for each day tabulated. During a very severe gale on December 28, 1900, the Osler instrument recorded a pressure of 44·4 pounds on the square foot, the resulting maximum velocity shown by the Dines' anemometer being eighty-two miles.

M. ARÇTOWSKI, of the *Belgica* Expedition, contributes to *Ciel et Terre* a note on the climate of glacial periods. Assuming the changes in the level of the snow-line to have been due to changes of temperature only, M. Arçtowski compares its present position at Cape Horn and in South Georgia, and estimates the corresponding differences of mean temperature, obtaining for a difference of level of 800 to 900 metres a difference of temperature of about 8° C. He urges the special importance of studying the conditions in oceanic climates, and expresses the opinion that the exploration of the Antarctic regions will give the true explanation of the occurrence of glacial periods.

WE have received from the authors a reprint of a paper published in the *Memoires* of the Belgian Academy of Sciences, by MM. H. Arçtowski and A. F. Renard, on the soundings and bottom deposits obtained during the expedition of the *Belgica*. Although this is a preliminary report, it is not expected that the detailed examination of the deposits, which remains to be completed, will seriously modify the conclusions arrived at. The most important points disclosed by the soundings are the existence of a depression of 4040 metres to the south of Staten Island, and of a continental plateau extending south of the 70th parallel. It is noteworthy that the boundary of this plateau is indicated by the isobath of 500 metres rather than by the usual 200 metres. In examining the deposits, the methods employed by Thoulet have been employed in preference to those of Murray and Renard, as the samples are chiefly terrigenous. The chief interest lies in the obvious iceberg origin of most of the deposits, indicating the presence of glaciers on continental land to the south and east of the region of the *Belgica's* drift. Another feature is the interruption of the zone of diatom ooze in this region.

AN account of the first voyage of the Norwegian fishery steamer, *Michael Sars*, during the summer of 1900, by Prof. Hjort, is published in the last two numbers of *Petermann's Mitteilungen*. The paper consists of three distinct parts—(1) oceanographical results, by Bjorn Helland-Hausen; (2) the distribution of some of the chief forms of Plankton in the Norwegian Sea, by Dr. H. H. Gran; and (3) fishery investigations, by Dr. Hjort. The course of the expedition was from Bergen, across to Iceland, along its north coast to Denmark Strait, thence to Jan Mayen, the Lafotens, Porsanger Fjord, Bear Island, westward to near long. 10° E., and home. The cruise lasted from July to September, and these preliminary results afford important extension and confirmation of the work of the Danish *Ingolf* expedition in the same regions.

THE July Pilot Chart for the North Atlantic and Mediterranean, issued by the Meteorological Office, shows graphically the general circulation of the air and of the sea for the month. The region in which gales form as much as 10 per cent. of the wind observations is now limited to the immediate neighbourhood of the southern extremity of Greenland. With the month of July the conditions in the tropics begin to assume a more disturbed appearance, and the seaman consequently finds the letterpress to be largely devoted to a description of West Indian hurricanes and a concise summary of practical rules for handling ships in or near these storms. The path of one of the hurricanes of July 1837 is shown on the chart. As only 355 hurricanes have been recorded in 300 years, the annual average is little more than one, but in July 33 were experienced last century, so that one may be expected every three years in this month. A good deal of information is given on the winds in the Dardanelles. An inset chart gives a thunderstorm type of pressure distribution over western Europe, the remarks stating that there are three distinct classes, (1) those coming from the southward; (2) those forming locally; and (3) those appearing as secondaries to depressions in the north. The first of these is the one illustrated. It is interesting to observe how the shading representing fog has been expanding month by month, until in July it extends without a break right across the Atlantic between 40° and 50° N., but it is only about the middle of the Bank of Newfoundland that the frequency amounts to 50 per cent. Mariners going up the Labrador coast are informed that during the few days of summer the displacement of the horizon by mirage in this neighbourhood occasions great difficulty in obtaining good observations for position. The north-eastward extension of the Gulf Stream drift towards our coasts, which was shown to be interrupted in May and re-established in June, is again overcome by a general southward flow of the surface water between 10° and 30° W., the Gulf Stream water apparently not extending northward of the 50th parallel even on the western side of the ocean. Icebergs have at last appeared about the banks, a number having been sighted between April 30 and June 1, nearly all clustering about 48° N. 48° W., but one in 46° N. 56° W.

WE drew attention in NATURE (January 17) to the first number of the *Geologisches Centralblatt*, which is edited by Prof. Dr. K. Keilhack. We have since received Nos. 2 to 10, the last named published on May 15. The total number of works dealt with is 1027, so that our estimate that about 2500 will be recorded in the year is probably correct. It is hardly possible to judge of the completeness of the record until the volume for the year is published, but we think that space could be saved by shorter notices of works that are not original articles, such as excursion notes, popular general papers on geology and economic products, text-books, &c. As an illustration of somewhat unequal treatment we observe that the notice of the Summary of Progress of the Geological Survey of the United Kingdom occupies two pages, and that of the Summary Report of the Geological Survey of Canada only five lines. A valuable feature in the work is the insertion of tables showing new groupings of strata and revised classifications of organic remains. Taken as a whole, it cannot fail to be of permanent service to geologists.

THE University of Nebraska publishes a contribution (No. 5) to the Botanical Survey of Nebraska, conducted by the botanical seminar. The present instalment consists of a number of papers on the general features of the flora rather than of lists of species.

IN the *Journal* of the Royal Microscopical Society for April and June are two of Mr. E. M. Nelson's useful papers on the construction of the microscope—on tube length and on the working aperture. Mr. Nelson points out that there are no less than three different measurements known as tube lengths, viz. the mechanical tube, the natural optical tube length, and the conventional optical tube length. A table is given of the variations in the lengths of the two different optical tubes for the objectives of various makers and the effect these variations have upon the power. In the second paper Mr. Nelson advocates the importance of distinguishing more accurately than has hitherto been the practice the precise ratio of the diameter of that part of the objective which is utilised to the diameter of the lens itself.

THE report of the experiments superintended by the Department of Agriculture in Cambridge University has just been issued. The experiments are conducted on various farms in the adjoining counties, which contribute towards the expenses of the Agricultural Department at the University. The volume issued is really a bundle of reports written by different persons, and no attempt is made to describe the work as a whole. Most of the experiments are of considerable interest, and will be of practical value in their respective localities. More exact descriptions of the conditions of each experiment are, however, required if any real addition to our knowledge is intended. An analysis of a soil conveys no certain information unless we know the depth which the sample represents. We cannot interpret the variable action of manures unless we know the rainfall during the seasons in question.

IN part iv. of vol. xxii. of the *Notes* from the Leyden Museum, Dr. O. Finsch catalogues the birds of the "South-west Islands," with three coloured plates of some of the less known species. The small islands in question form a chain stretching from the northern extremity of Timor in an easterly direction to Timorlaut. Although the birds from some of these islets have been described by the officials of the Tring Museum, of others the bird-fauna is practically unknown. Dr. Finsch records a total of 123 species. One of the most striking and beautiful of these is the great red-brown fruit-pigeon named by Schlegel in honour of Dr. Hoedt, a former worker on the avifauna of these islands. For the future, the author suggests that this bird should represent a genus by itself, and be known as *Alopecaenus hoedti*.

THE number of new generic, specific and subspecific names that have been proposed for North American mammals during the last twenty years is so enormous that it was a matter of the greatest difficulty for a student to be certain that he had exhausted the list in any particular group upon which he might be engaged. This difficulty has been removed by the appearance of a "Synopsis of the Mammals of North America and the Adjacent Seas," by Dr. D. G. Elliot, which forms vol. ii. of the zoological series of publications of the Field Columbian Museum. The synopsis is well illustrated by reproductions from photographs of skulls. Although the author states that many of the species and subspecies recorded are probably nominal, the task of abolishing such superfluous names is left to his successors. In the main the work appears to be very accurate, but we notice a few omissions, and when describing the wood-bison the author states that it is a larger animal than its cousin of the plains, although the measurements given of the two forms indicate just the contrary.

IN the issue of *Die Umschau* of June 15, Prof. W. Amalitzky announces the discovery of gigantic anomodont and other reptiles in a Permian deposit at Sokolki, on the Dwina, Russia. The bones occur in an old river channel cut in Lower Permian beds and subsequently filled up with sandstone. Regular excavations have been undertaken, with the result that a very large number of skeletons and separate bones have been disinterred. Most of these are embedded in hard nodules, and a considerable sum of money is required for their proper development. Most noticeable is the discovery of no less than from fifteen to twenty skeletons of the huge anomodont Pariasaurus, hitherto known only from South Africa. One of these has been developed, and measures 11 feet in length. Remains of Dicynodon and other anomodonts, as well as dinosaurs and a labyrinthodont, are likewise recorded. According to Prof. Amalitzky, the reptilian remains are associated with ferns belonging to the well-known "Glossopteris flora"; and it would accordingly appear that this peculiar southern fauna and flora, which formed a belt round the globe in low latitudes during early Mesozoic times, had a northern extension into eastern Europe.

THE *American Museum Journal* for April and May contains a figure of one of five specimens of the Greenland musk-ox which have recently been mounted for exhibition. This form of musk-ox, it will be remembered, was described not long ago in NATURE as *Ovibos moschatus wardi*; and the American Museum has now acquired a fine series of specimens, which have enabled Dr. J. A. Allen to point out characters regarded as sufficient to justify the assignation of specific rank to this animal. On a later page of the same journal, stress is laid on the importance of exhibiting in museums groups of mounted mammals and birds amid their natural surroundings, as it is by this means alone that their full educational value can be obtained from the specimens. By the aid of liberal donations from private sources, much has already been done in this way in the American Museum, and it is confidently hoped that still more will be accomplished in the near future. It is a matter for regret that, so far as the larger mammals are concerned, little or nothing of this sort has hitherto been attempted in our own national collection. But millionaires in this country do not seem inclined to devote some of their spare thousands to such objects.

AN address on the historical development and the problems of anthropology, delivered by Dr. B. Hagen at the anniversary gathering of the Senckenberg Society of Natural Science, Frankfort on the Main, last year, has been translated by Mr. W. L. H. Duckworth and published by the Anthropological Laboratory, Cambridge. According to the translation, which alone has reached us, Dr. Hagen adopts a common but somewhat arbitrary division of the science of man into "anthropology," which deals with the physical structure of man and "the mode of life," and into "ethnology," or psychical aspect, comprising folk-lore, comparative psychology, sociology and psycho-physics. It is not clear what "the mode of life" means or why that is regarded as physical and the investigation of the senses and sense organ entirely relegated to "ethnology." Speaking of craniology, Dr. Hagen states that "we are not at the present day in a position to determine with certainty the racial identity of a given skull, with the exception, perhaps, of hyper-typical examples of Australians or Negroes." He believes there is but a single cranial type, the mesocephalic, of whose varieties the dolichocephals and brachycephals are the opposite extremes. "Stature is also a dangerous pitfall for metrical anthropology in general." Evidently the "anthropologists" of this classification cannot reduce the facts of the study of man into order without the help of the "ethnologists;" but we are warned that "the linguist must not regard the ethnologist, nor he in turn the anthropologist, with disdain."

CATALASE is the name given to a new enzyme of general occurrence described by Dr. Oscar Loew in Report (No. 68) of the U.S. Department of Agriculture (Division of Vegetable Physiology and Pathology) with special reference to the tobacco plant. This enzyme possesses the power of producing catalytic decomposition of hydrogen peroxide, a decomposition which, according to the author's experiments, is probably not produced by any other known enzyme. The enzyme appears to exist in an insoluble and in a soluble form, which are designated α- and β-catalase respectively. The former is probably a compound of the soluble catalase with a nucleo-proteid, while the β- form is an albuminose and can be liberated by the action of very dilute alkaline media upon the insoluble catalase. The behaviour of the enzyme towards various salts, acids, bases and other reagents has been carefully investigated. Experiments on the nature of catalase indicate that it is an oxidising enzyme, the most characteristic reaction studied in this direction being its rapid oxidation of hydroquinone to quinone. Numerous tests have established the general occurrence of catalase in the vegetable kingdon. No living plant or vegetable organ tested was found free from it, some plants containing more of the soluble, others more of the insoluble, form. In the animal kingdom it also appears to be widely distributed, having been found in aqueous extracts of spleen, pancreas, liver, kidney, brain, muscles and blood serum. Infusoria, insects, worms and molluscs were also examined, with positive results.

THE additions to the Zoological Society's Gardens during the past week include two North African Jackals (*Canis anthus*) from Algeria, presented by Mr. G. E. Hope; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mrs. Mould; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Captain R. Feilden; a Leopard (*Felis pardus*) from Africa, presented by Captain G. Burrows; two Stanley Cranes (*Anthropoides paradisea*) from South Africa, presented by Mr. A. W. Guthrie; a Yellow-cheeked Amazon (*Chrysotis autumnalis*) from Honduras, presented by Mrs. Bullock; a Rough-legged Buzzard (*Archibuteo lagopus*) from Norway, presented by Dr. E. A. Williams; a Leopard Tortoise (*Testudo pardalis*) from South Africa, presented by Major J. Day; five Leith's Tortoises (*Testudo leithi*), eight Basilisk Chameleons (*Chamaeleon basiliscus*), two Common Chameleons (*Chamaeleon vulgaris*), three Schneider's Skinks (*Eumeces schneideri*) from Egypt, presented by Mr. Stanley S. Flower; a Spix's Macaw (*Cyanopsittacus spixi*) from North Brazil, two Barbary Wild Sheep (*Ovis tragelaphus*) from North Africa, a West African Python (*Python sebae*) from West Africa, fourteen North American Trionyx (*Trionyx ferox*), six Lesueur's Terrapins (*Malacoclemmys lesueuri*) from North America, seven Roofed Terrapins (*Kachuga tectum*) from India, two South American Rat Snakes (*Spilotes pullatus*) from South America, three Cunningham's Skinks (*Egernia cunninghami*) from Australia, two Wallace's Lories (*Eos wallacei*) from Waigiou, a New Zealand Parrakeet (*Cyanorhamphus novae-zealandiae*) from New Zealand, deposited; two Spoonbills (*Platalea leucorodia*), European, purchased; a Burrhel Wild Sheep (*Ovis burrhel*), a Squirrel-like Phalanger (*Petaurus sciureus*), two White Ibises (*Eudocimus albus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

SPECTRUM OF NOVA PERSEI.—In the current issue of *Comptes rendus* (vol. cxxxii. pp. 1542-1544) M. Deslandres gives a third series of observations of the spectrum of Nova Persei as obtained at the Meudon Observatory. Since the previous communication, spectrographs of varying power have been installed for use with the two telescopes of 0·84 metre and 0·60 metre aperture, and both photographic and visual records of the spectrum obtained during the periods of minima, although unfavourable weather has considerably interfered with their continuity. In this later work special attention has been devoted to the expected detection of the principal nebular lines. M. Deslandres states that during the first stages the principal green lines present were distinctly not the nebular lines, but the lines of parhelium, λ492 and λ5015, this being well shown in a photograph taken on March 3. On a plate taken on April 17, however, the measured position of the chief green line was λ5008, but on account of breadth of line the value is of course only approximate. The star was near its minimum brightness on this date. The gradual varying intensity of this line relative to the H_β line of hydrogen is then described, the details being in close agreement with those already published by other observers.

On May 14 a fainter line was seen near the next nebular line, about λ4959, the star being less than 7th magnitude, and he concludes that at that time the spectrum of the Nova was completely nebular, also mentioning that M. de Gothard had detected the ultra-violet nebular line λ386 in the spectrum of the star.

DARK SPOT ON JUPITER.—In the *Astronomische Nachrichten* (No. 3724) Mr. T. E. R. Phillips gives the results of several observations by others and himself extending from March 2 to June 2.

The spot as seen by these observers is in the white north tropical zone, in about latitude +15°. At present it appears to be quite detached from the northern edge of the north equatorial belt, but when first seen gave the impression of being merely a dark projection from that belt into the north tropical zone. Possibly the reason for the present appearance is the apparent narrowing of the belt which has been observed for some time past.

A table is given showing the results of nine determinations, the discussion of which indicates a period of 9h. 55m. 29·7s.

THE METEORIC EPOCH OF JULY AND AUGUST.

METEORS are generally rare in the early part of the year, and, in May and June, twilight is so strong that it obliterates faint objects and leaves only the more conspicuous class of meteors observable. But in July, though the sky is still very light and the nights extremely short, these objects become fairly plentiful and particularly so during the last week of the month, when the horary rate of apparition is about three times as great as it is on ordinary nights of spring and midsummer. The meteoric observer regards July and August not only as one of the most productive seasons of work, but one which in the interesting character of its results will compare favourably with that of any other epoch of the year.

There is a rich shower of Aquarids annually visible on about July 27-31, and apart from this stream the great system of Perseids, which has rendered the month of August so famous in meteoric annals, has actively commenced and supplies no inconsiderable proportion of the shooting stars visible at the close of July. Other showers are plentifully distributed over the firmament, but the majority are very feeble and may only be distinguished by close and prolonged watching during several clear nights.

The writer recently undertook the rediscussion of about 260 meteors which he has recorded from the shower of Aquarids, in various years, with a view to discover whether there were any indications of motion in the radiant. Grouping the observations into short periods and deducing the place of the radiant for each of them, it was found that no displacements occurred other than those which might be fairly attributed to errors in registering the paths. The radiants came out as follow:—

	α °	δ °	
July 23-25 ...	... 335	− 11	11 meteors
July 26-31 ...	.. 338	− 12	190 ,,
August 1-5 ...	... 337	− 12	18 ,,
August 6-13 ...	... 335	− 11	12 ,,
August 14, 1887	... 335	− 10	5 ,,
August 18-25 ...	... 339	− 11	20 ,,

The centre of radiation, like that of the October Orionids, appears, therefore, to be motionless, and it continues visible for more than a month. In observing this stream care must be taken not to confuse it with two other pretty rich and contemporary showers at 345° ± 0° and 339° − 30°. The latter is near the bright southern star Fomalhaut.

In this department the observer's efforts have to be regulated in a great measure by moonlight, and this year our satellite will interfere in the earlier and later part of July. But it is probable that, with suitable weather, the first indications of the Perseid display may be well observed on about July 11-15. As the radiant centre of this system travels E.N.E. with the time, the observer should keep his materials for each night separate, and determine the place of radiation on every date when the conformable paths are adequate for that purpose. This position can scarcely be defined, either with safety or accuracy, when less than five well-observed meteors have been registered from it. But it is often satisfactorily obtained when two observers at separate stations record the same meteor. In a case like this the evidence is conclusive as to the position of the radiant, though it may be rendered a little inexact by errors of observation. But in instances where meteors are seen at one place only there are possibilities of mistake in attributing the radiants, for these have necessarily to be assumed from the directions of flight and visible aspect of the objects observed. In the case of the Perseid shower there is not, however, much probability that serious errors will occur in this respect, but everything depends upon the discrimination and discretion of the observer.

In recent years many amateurs have participated in systematic observations of the Perseids, and the number of doubly observed meteors has been greatly augmented. In July, 1900, three early Perseids were recorded in duplicate and gave heights and radiants as follow :—

	Height at beginning. Miles.	Height at end. Miles.	Radiant. ° °
July 19	81 ...	54 ...	17+50
,, 23	84 ...	55 ...	24+52
,, 30	95 ...	50 ...	30+52

In time it will be possible to accumulate a sufficient number of these observations to assign the radiant on every night during the last half of July. There will certainly be small errors in the individual positions, and they will not absolutely agree in showing the regular progression of the radiant eastwards, but the mean places derived from a considerable number of meteors will no doubt yield very satisfactory results.

In previous years much has been effected at the July and August epoch, but still more remains to be done. Photography, of which so much was expected, has achieved little, but its possibilities are great and it may ultimately prove as successful in this department as it has done in several others. The fact, however, remains that we are still mainly dependent upon eye observations, though they are no more than rough and hurried estimates of position, and scarcely capable of being usefully employed in any refined or critical investigations of the subject. But with care and long practice it is possible to acquire a degree of accuracy which would hardly have been credited, and we must not forget that some important conclusions have been safely based on rough eye observations. The virtual identity of comets and meteors has been established, the heights and velocities of meteors approximately determined, while the positions of some hundreds of radiants have been ascertained with fair accuracy. Features such as the motion of the Perseid centre, the stationary aspect of the Orionid and certain other radiants, and the large area of radiation of the meteors of Biela's comet, have been demonstrated. But much additional data are required, and as photography has hitherto supplied very meagre results, observers have to fall back upon the old-time method as vastly more productive if far less precise. It will be remembered that some years ago it was thought that the photographic plate would soon supersede the observer in regard to the delineation of planetary detail, but this idea has not been realised. It is true that planetary and meteoric observations are different and therefore not strictly comparable, but we have gained enough experience to see that the meteoric observer is in no immediate danger of being displaced. W. F. DENNING.

THE "EDISON" STORAGE CELL.

CONSIDERABLE interest was aroused a short time ago by the announcement that Mr. Edison had invented a new secondary battery. As was only to be expected of a rumour, circulated mainly by the lay Press and dealing with one of Mr. Edison's inventions, it was said that the new cell was going to revolutionise entirely the electrical storage of energy and to throw open to the undisputed control of the electrical engineer the much-desired field of motor-car work. Fortunately, in this case, even if rumour has been somewhat extravagant, it has not been without foundation. Mr. Edison has in reality invented a new storage cell which is novel in principle and full of promise. A full description of the invention was given by Dr. A. E. Kennelly at the annual meeting of the American Institute of Electrical Engineers on May 21, and we are able, from a reprint of this paper which appeared in the *Electrical Review* of New York (May 25), to obtain data for a preliminary consideration of the merits of the cell.

Mr. Edison—like many other inventors, only with more success than is met with by most—set out with the object of devising a cell which should possess the following merits :—(1) Absence of deterioration by work, (2) large storage capacity per unit of mass, (3) capability of being rapidly charged and discharged, (4) ability to withstand careless treatment, and (5) inexpensiveness.

It will be best first to describe the solution that Mr. Edison has offered, and then to examine, as far as is possible from the information available, to how great a degree the above requirements are satisfied. The problem thus clearly stated by Dr. Kennelly is one which has been long realised by all interested in the matter, and by none, perhaps, more than by the makers and users of motor-cars. The one great difficulty in the construction of a good electrical motor-car, or in the equipment of a satisfactory system of accumulator tramways, has been the want of a suitable storage cell. If this were only provided, we have been told, then the electrical motor-car would know no rival, seeing that it would be free from all the objectionable noise and smell incidental to petroleum automobiles. It is, therefore, most earnestly to be hoped that the new Edison cell will do all that is claimed for it.

The cell is an entirely new departure in storage batteries, the materials used in its construction being iron and nickel oxide. The active material of the negative plate of the cell consists of iron, that of the positive plate of a superoxide of nickel believed to have the formula NiO_2. Thus the iron corresponds to the spongy lead and the oxide of nickel to the lead peroxide of a lead accumulator. The electrolyte used is an aqueous solution containing about 20 per cent. by weight of caustic potash. The E.M.F. of this combination—iron, potassium hydrate, nickel superoxide—is about 1·5 volts when fully charged and falls to about 1·15 at the end of the useful discharge. At the end of the discharge the iron is oxidised and the nickel oxide reduced ; the charging process carries back the oxygen through the potash solution from the iron to the nickel plate, the energy being thus stored in the reduced iron, which, though unaffected by the solution in ordinary circumstances, is reoxidised when the cell is allowed to discharge. The solution, therefore, does

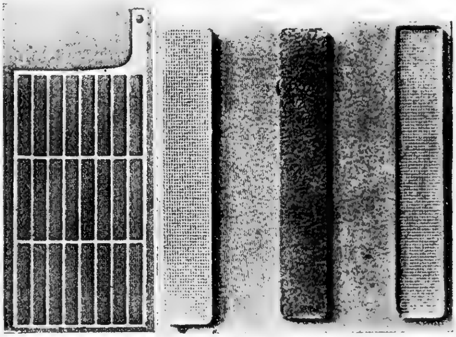


FIG. 1.—Grids and Briquettes, Edison Storage Battery. (From *The Electro-Chemist and Metallurgist.*)

not apparently enter at all into the chemical action which takes place, but only serves as a vehicle for transporting oxygen from the one plate to the other ; this is of considerable advantage, as it allows a minimum of solution to be employed.

The mechanical construction of the two plates is identical, the only difference between them being in the active material used. The plates are made of comparatively thin sheets of steel (a little more than 0·5 mm. thick), out of which rectangular holes or "windows" are stamped. In the plates exhibited there were three rows of eight such windows, these holes occupying, of course, by far the greater proportion of the area, the steel framework being merely sufficient for strength and rigidity. Into these holes are fitted small nickel-plated steel boxes containing the active material in the form of closely consolidated briquettes. These boxes are somewhat thicker than the grid, being about 2·5 mm. thick in the finished plate, and are perforated, back and front, with numerous small holes to allow access of the electrolyte to the active material. The general appearance of the grid and briquettes can be seen from Fig. 1.

The positive briquettes are made by mixing a finely divided compound of iron with a nearly equal volume of thin flakes of graphite, the graphite being added to increase the conductivity of the briquettes. The mixture is pressed in a mould under an hydraulic pressure of about two tons per square inch. The surface area of each face of the briquette is about 3 inches by ½ inch. The negative briquettes are made in a precisely similar way, only a compound of nickel is used in place of the compound of iron. The method by which these compounds are obtained and their constitution was not described in Dr. Kennelly's paper, but from the patent specification it appears that the compound of iron used is the monosulphide, FeS, which is formed after being made up into the briquettes by electrolytic oxidation in a solution of potassium hydroxide. The superoxide of nickel is prepared in the same manner by electrolytic oxidation of the ordinary hydrated oxide of the metal. Cobalt, it is said, can be used instead, but is more expensive. The briquettes of active material are placed in the little nickel-plated steel boxes, a cover is put on, and the boxes are then inserted in the "windows" of the grid. The assembled plate is then subjected in an hydraulic press to a pressure of about 100 tons (about 1 or 1½ tons per square inch), thus tightly closing the boxes and, by bending their sides over the edges of the recesses in the grid, fixing them firmly in position and making the whole into a rigid plate. The plates are separated, positive from negative, by thin perforated sheets of hard rubber, and are placed in a steel box which is filled up with the potash solution. The cell is then charged by passing current through it from the nickel to the iron plate, thus oxidising the nickel compound to superoxide of nickel and reducing the iron compound to spongy metallic iron.

It is obviously impossible to say at present how far this cell will satisfy the five conditions already stated. With regard to the first and the last, for example, no data are as yet available. The first is naturally one of the most important considerations, since it is necessary not merely that the cell should have a long life, but that it should not deteriorate too much even when subjected to somewhat careless treatment, as it is certain to be if it come into at all general use for motor-cars. Certain experiments which were quoted by Dr. Kennelly lead, however, to the hope that the cell will not be found wanting in this respect. Thus it was stated that the battery would stand without injury, not only being completely run down, but even being afterwards charged in the wrong direction. Mr. Edison also states that the nickel plate can be removed from the cell and dried in the air for a week without being injured, and if charged when thus removed will not appreciably lose its charge. The iron plate, if similarly treated, will lose its charge by the slow oxidation of the spongy iron, but will not be in any way permanently injured.

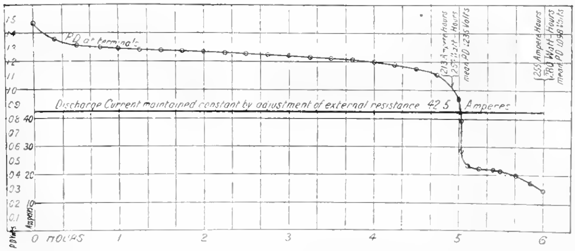


FIG. 2.—Curve of discharge of Edison cell weighing 25 pounds.

Perhaps the consideration that appeals most directly to motor-car users is lightness, or large storage capacity per unit weight. In this respect the cell compares very favourably with lead accumulators. According to Dr. Kennelly the storage capacity of the modern lead accumulator is from 4 to 6 watt-hours per lb., or from 9 to 13 watt-hours per kilogramme, whereas the Edison cell is said to have a capacity of 14 watt-hours per lb. (31 watt hours per kilogramme). It will be interesting to examine these figures a little more closely to see whether this claim to an increased storage capacity of about 3½ times is in reality justified. We reproduce in Fig. 2 a discharge curve for an Edison cell weighing 25lbs., discharging at 42·5 amperes for six hours. It will be seen that after five hours' discharge the voltage drops from 1·45 to 1·0 volt; although it may be possible to obtain the remaining hour's discharge without injury to the cell, yet it is very questionable whether this extra energy at so low a voltage as 0·5 volt would be found useful in practice. We are quite justified in saying, therefore, that this cell is only capable of giving five hours' discharge at 42·5 amperes, thus having a capacity of 213 ampere-hours, or 260 watt-hours. It has, therefore, a capacity of 10 watt-hours per lb. (22 per kilogramme), a figure somewhat lower than that given by Dr. Kennelly in the body of his paper. In an article on accumulators which appeared recently in the *Electro-Chemist and Metallurgist* (May 1901, p. 116), Mr. J. H. West gives a carefully calculated table of the capacities of all the principal accumulators exhibited at the Paris Exhibition or which took part in the Automobile Club competition of 1899. We can take from this table the figures relating to accumulators having a capacity of 200 ampere-hours and discharging in five hours, which are exactly comparable, therefore, with the Edison cell, the discharge curve of which is given in Fig. 2. Calculating from these data we get the results given in the accompanying table; there are 19 cells included in Mr. West's list, but as some of these are heavy cells intended for stationary work, a mean result has been worked out in which the heavier cells are neglected as well as a mean for the whole number.

TABLE.

Cell	Energy stored	
	Watt-hours per kilogramme	Watt-hours per pound
Mean of all cells in Mr. West's table	7	3
Mean of lighter cells ,, ,,	13	6
Lightest cell (Sherrin) ,, ,,	26	12
Edison's cell, from curve	22	10
,, ,, Dr. Kennelly's figures...	31	14

As the figures given by Mr. West only refer to ampere-hours, we have assumed in calculating the table that the mean voltage during discharge is 1·85 volts, a somewhat low estimate, and one therefore favouring the Edison cell in the above comparison. It will be seen from this table that the Edison cell when compared with the lightest lead accumulator obtainable is by no means so pre-eminent as regards energy capacity per unit weight. The Sherrin cell, it may be remarked, came very successfully through the Automobile Club's competition, being the only one which did not fall below the specified voltage more than three times during the trials. Although the figures given above may seem to militate against the claims advanced in favour of the new battery, it must be remembered that high storage capacity is not the only advantage that it is said to possess; even if it were no better than lead cells in this respect, if it proves superior to them in the other four conditions it will be a great advance. Also it must not be forgotten that the cell is quite new and that no doubt great improvement may be looked for when it is produced in large quantities.

THE BIOLOGY OF MOUNT SHASTA.

THE results of a biological survey of Mount Shasta, California, are contained in a *Bulletin*[1] recently received. This publication of 169 pages, with forty-six text illustrations and five heliotype plates, is a worthy successor to its forerunners, now so well known, and in every respect equal to the best of them.

It is the result of an investigation by the Biological Division of the U.S. Department of Agriculture under Dr. C. Hart Merriam, chief of the Biological Survey, which was decided upon in 1898, after the completion of the exploration of southern, middle, and north-east portions of the vast Californian area. The great altitude of the mountain (14,450 feet), and its position between the Sierra Nevada and the Cascades of

1 "North American Fauna," No. 16. U.S. Department of Agriculture. Washington: Government Printing Office, 1899.)

Oregon, invest it with an exceptional interest, in relation to the question of the probable limitations in distribution of the animals and plants peculiar to these; and in the end the unexpected result has been obtained that, although the gap between the Shasta and the Cascades is far less than between it and the Sierra Range, and while plants and animals representative of both ranges are present upon it, the Sierra species are predominant.

In the course of the expedition names were given to newly-discovered peaks and canyons, and at points in the ascent favourable for work and observation individual members of the exploring party were left encamped, in one case for a period of well-nigh a couple of months. The net result biologically has been the discovery of five new species of plants, eight of mammals.

The Report opens with a description of the general features of the mountain; and its glaciers, basins, canyons, streams, slopes, timber-lines, and other natural features, are in turn dealt with in an amply and beautifully illustrated manner.

There then follows a systematic report upon the forest trees and a description of the life zones above 5500 feet, that being the altitude of limitation of the "transition zone" of the mountain, the facies of which are those of the surrounding country. The fauna and flora of this are given, and the superposed heights are next dealt with under zones as follows: the Canadian zone, of 2000 feet, which is defined as a "continuous forest of stately trees"; the Hudsonian, also of 2000, the highest of the timber-belts, characterised by the presence of but two species of trees—a hemlock and a white-bark pine; and the Alpine zone, or that occupying the interval between the timber-line and upper limit of plant growth.

The fauna and flora of each of these are in turn given in full in the form of classified lists of species. Then follows a discussion, with comparison, of the boreal flora and fauna of Shasta and the Sierra and Cascades, again with classificatory lists, and of the surrounding gaps and rivers, regarded as barriers to boreal species. The greater part of the Report which remains consists of a systematic list of the mammals and birds of the area, arranged in order of classification, with full diagnoses and measurements, and "remarks" which embody interesting observations on the habits of more especially the burrowing animals. There follows a chapter on the distribution of the Shasta plants. Concerning the zoological synonymy, many who are familiar with Dr. Merriam's work will be prepared for sub-species and what we in Europe are apt to regard as splitting. In this Report there is little of it, and when the richness of the materials which Dr. Merriam and his contemporaries usually command is borne in mind, criticism of this order were best left in abeyance. In the course of the strictly zoological portion of the Report several new text illustrations are introduced, and any more life-like and fascinating than those of the Rock Cony (*Ochotona* [*Lagomys*]), the Mink (*Lutreola*) and Marten, or among the birds, of the Red Tail and the Clark Crow it would be difficult to imagine.

Shasta is characterised by nothing better than its scanty moisture, and the effect of this on the plant population and zonal distribution is fully discussed. We have nought but the highest praise for this Report. It fills us with envy and arouses feelings of mute admiration for the enterprise of Dr. Merriam and his co-workers in the field. It is worthy the nation that will levy a tax to aid in the foundation and maintenance of a university, and where wealth, long lavished on scientific exploration of the land of their birth, is now bringing its reward of commercial prosperity.

THE NADIR OF TEMPERATURE AND ALLIED PROBLEMS.[1]

DETAILS are given in this paper which have led to the following results:—

The helium thermometer which records 20°·5 absolute as the boiling point of hydrogen, gives as the melting point 16° absolute. This value does not differ greatly from the value previously deduced from the use of hydrogen gas thermometers, viz., 16°·7. The lowest temperature recorded by gas thermometry is 14°·5, but with more complete isolation and a lower pressure of exhaustion, it will be possible to reach about 13° absolute, which is the lowest temperature that can be commanded by the use of solid hydrogen. Until the experiments are repeated with a helium gas thermometer filled at different pressures, with the gas previously purified by cooling to the lowest temperature that can be reached by the use of solid hydrogen, no more accurate values can be deduced.

The latent heat of liquid hydrogen about the boiling point as deduced from the vapour pressures and helium-thermometer temperatures is about 200 units, and the latent heat of solid hydrogen is about 16 units.

The order of the specific heat of liquid hydrogen has been determined by observing the percentage of liquid that has to be quickly evaporated under exhaustion in order to reduce the temperature to the melting point of hydrogen, the vacuum vessel in which the experiment is made being immersed in liquid air. It was found that in the case of hydrogen the amount that had to be evaporated was 15 per cent. This value, along with the latent heat of evaporation, gives an average specific heat of the liquid between freezing and boiling point of about 6 When liquid nitrogen was similarly treated for comparison, the resulting specific heat of the liquid came out 0·43 or about 6 per atom. Hydrogen therefore follows the law of Dulong and Petit, and has the greatest specific heat of any known substance.

The same fine tube used in water, liquid air, and liquid hydrogen gave respectively the capillary ascents of 15·5, 2 and 5·5 divisions. The relative surface tension of water, liquid air and liquid hydrogen are therefore in the proportion of 15·5, 2, 0·4. In other words, the surface tension of hydrogen at its boiling point is about one-fifth that of liquid air under similar conditions. It does not exceed one thirty-fifth part the surface tension of water at the ordinary temperature.

The refractive index of liquid hydrogen determined by measuring the relative difference of focus for a parallel beam of light sent through a spherical vacuum vessel filled in succession with water, liquid oxygen and liquid hydrogen, gave the value 1·12. The theoretical value of the liquid refractive index is 1·11 at the boiling point of the liquid. This result is sufficient to show that hydrogen, like oxygen and nitrogen in the liquid condition, has a refractivity in accordance with theory.

Free hydrogen, helium and neon have been separated from air by two methods. The one depends on the use of liquid hydrogen to boil the dissolved gases out of air kept at a temperature near the melting point of nitrogen; the other on a simple arrangement for keeping the more volatile gases from getting into solution after separation by partial exhaustion. By the latter mode of working something like 1/34000th of the volume of the air liquefied appears as uncondensed gas. The latter method is only a qualitative one for the recognition and separation of a part of the hydrogen in air. In a former paper on the "Liquefaction of Air and the Detection of Impurities" (*Chem. Soc. Proc.*, 1897), it was shown that 100 c.c. of liquid air could dissolve 20 c.c. of hydrogen at the same temperature. The crude gas separated from air by the second method gave on analysis—hydrogen 32·5 per cent., nitrogen 8 per cent., helium, neon, &c., 60 per cent. After removing the hydrogen and nitrogen the neon can be solidified by cooling in liquid hydrogen and the more volatile portions separated.

There exists in air a gaseous material that may be separated without the liquefaction of the air. For this purpose air has to be sucked through a spiral tube filled with glass wool immersed in liquid air. After a considerable quantity of air has been passed, the spiral is exhausted at the low temperature of the liquid air bath. The spiral tube is now removed and allowed to heat up to the ordinary temperature, and the condensed gas taken out by the pump. After purification by spectroscopic fractionation, the gas filled into vacuum tubes gives the chief lines of xenon. The spectroscopic examination of the material will be dealt with in a separate paper by Prof. Liveing and myself. A similar experiment made with liquid air kept under exhaustion, the air current allowed to circulate being under a pressure less than the saturation pressure of the liquid to prevent liquefaction, resulted in crypton being deposited along with the xenon.

A study of fifteen electric resistance thermometers as far as the boiling point of hydrogen has been made, and the results

[1] (1) Physical Properties of Liquid and Solid Hydrogen. (2) Separation of Free Hydrogen and other Gases from Air. (3) Electric Resistance Thermometry at the Boiling Point of Hydrogen. (4) Experiments on the Liquefaction of Helium at the Melting Point of Hydrogen. (5) Pyro-electricity, Phosphorescence, &c. The Bakerian Lecture delivered at the Royal Society on June 13, by Prof. James Dewar, F.R.S.

reduced by the Callendar and Dickson methods. A table was given showing the results for seven thermometers, viz., two of platinum, one of gold, silver, copper and iron, and one of platinum-rhodium alloy.

It is noted that the lowest boiling point for hydrogen was given by the gold thermometer. Next to it came one of the platinum thermometers, and then silver, while copper and the iron differ from the gold value by 26 and 32 degrees respectively. The gold thermometer would make the boiling point 23°·5 instead of the 20°·5 given by the gas thermometer. Then the reduction of temperature under exhaustion amounts to only 1° instead of 4° as given by the gas thermometer. The extraordinary reduction in resistance of some of the metals at the boiling point of hydrogen is very remarkable. Thus copper has only 1/105th, gold 1/30th, platinum 1/35th to 1/17th, silver 1/24th the resistance at melting ice, whereas iron is only reduced to 1/8th part of the same initial resistance. The real law correlating electric resistance and temperature within the limits we are considering is unknown, and no thermometer of this kind can be relied on for giving accurate temperatures up to and below the boiling point of hydrogen. The curves are discussed in the paper, and I am indebted to Mr. J. H. D. Dickson and Mr. J. E. Petavel for help in this part of the work.

Helium separated from the gas of the King's Well, Bath, and purified by passing through a U-tube immersed in liquid hydrogen, was filled directly into the ordinary form of Cailletet gas receiver used with his apparatus and subjected to a pressure of 80 atmospheres, while a portion of the narrow part of the glass tube was immersed in liquid hydrogen. On sudden expansion from this pressure to atmospheric pressure a mist from the production of some solid body was clearly visible. After several compressions and expansions, the end of the tube contained a small amount of a solid body that passed directly into gas when the liquid hydrogen was removed and the tube kept in the vapour of hydrogen above the liquid. On lowering the temperature of the liquid hydrogen by exhaustion to its melting point, which is about 16° absolute, and repeating the expansions on the gas from which the solid had separated by the previous expansions at the boiling point or 20°·5, *no mist was seen*. From this it appears the mist was caused by some other material than helium, in all probability neon, and when the latter is removed no mist is seen, when the gas is expanded from 80 to 100 atmospheres, even although the tube is surrounded with solid hydrogen. From experiments made on hydrogen that had been similarly purified like the helium and used in the same apparatus, it appears a mist can be seen in hydrogen (under the same conditions of expansion as applied to the helium sample of gas) when the initial temperature of the expanding gas was twice the critical temperature, but it was not visible when the initial temperature was about two and a half times the critical temperature. This experience applied to interpret the helium experiments would make the critical temperature of the gas under 9° absolute.

Olszewski in his experiments expanded helium from about seven times the critical temperature under a pressure of 125 atmospheres. If the temperature is calculated from the adiabatic expansion starting at 21° absolute, an effective expansion of only 20 to 1 would reach 6°·3, and 10 to 1 of 8°·3. It is now safe to say, helium has been really cooled to 9° or 10° absolute without any appearance of liquefaction. There is one point, however, that must be considered, and that is the small refractivity of helium as compared to hydrogen, which, as Lord Rayleigh has shown, is not more than one-fourth the latter gas. Now as the liquid refractivities are substantially in the same ratio as the gaseous refractivities in the case of hydrogen and oxygen, and the refractive index of liquid hydrogen is about 1·12, then the value for liquid helium should be about 1·03, both taken at their respective boiling points. In other words, liquid helium at its boiling point would have a refractive index of about the same value as liquid hydrogen at its critical point, and as a consequence, small drops of liquid helium forming in the gas near its critical point would be far more difficult to see than in the case of hydrogen similarly situated.

The hope of being able to liquefy helium, which would appear to have a boiling point of about 5° absolute, or one-fourth that of liquid hydrogen, is dependent on subjecting helium to the same process that succeeds with hydrogen; only instead of using liquid air under exhaustion as the primary cooling agent, liquid hydrogen under exhaustion must be employed, and the resulting liquid collected in vacuum vessels surrounded with liquid hydrogen. The following table embodies the results of experience and theory :—

Initial temperature.	Initial temperature.	Critical temperature.	Boiling points.
Liquid helium ? ...	5° ?	2° ?	1° ?
Solid hydrogen ...	15	6	4
Liquid ,, ...	20	8	5 (He ?)
Exhausted liquid air	75	30	20 (H)
52° C.	325	130	86 (Air)
Low red heat ...	760	304	195 (CO_2)

The first column gives the initial temperature before continuous expansion through a regenerator, the second the critical point of the gas that can be liquefied under such conditions, and the third the boiling point of the resulting liquid. It will be seen that by the use of liquid or solid hydrogen as a cooling agent we ought to be able to liquefy a body having a critical point of about 6° to 8° absolute and boiling point of about 4° or 5° absolute. Then, if liquid helium could be produced with the probable boiling point of 5° absolute this substance would not enable us to reach the zero of temperature; another gas must be found that is as much more volatile than helium as it is than hydrogen in order to reach within 1° of the zero of temperature. If the helium group comprises a substance having the atomic weight 2, or half that of helium, such a gas would bring us nearer the desired goal. In the meantime the production of liquid helium is a difficult and expensive enough problem to occupy the scientific world for many a day.

A number of miscellaneous observations have been made in the course of this inquiry, among which the following may be mentioned. Thus the great increase of phosphorescence in the case of organic bodies cooled to the boiling point of hydrogen under light stimulation is very marked, when compared with the same effects, brought about by the use of liquid air. A body like sulphide of zinc cooled to 21° absolute and exposed to light shows brilliant phosphorescence on the temperature being allowed to rise. Bodies like radium that exhibit self-luminosity in the dark, cooled in liquid hydrogen maintain their luminosity unimpaired. Photographic action is still active although it is reduced to about half the intensity it bears at the temperature of liquid air. Some crystals when placed in liquid hydrogen become for a time self-luminous, on account of the high electric stimulation brought about by the cooling causing actual electric discharges between the crystal molecules. This is very marked with some platino-cyanides and nitrate of uranium. Even cooling such crystals to the temperature of liquid air is sufficient to develop marked electrical and luminous effects.

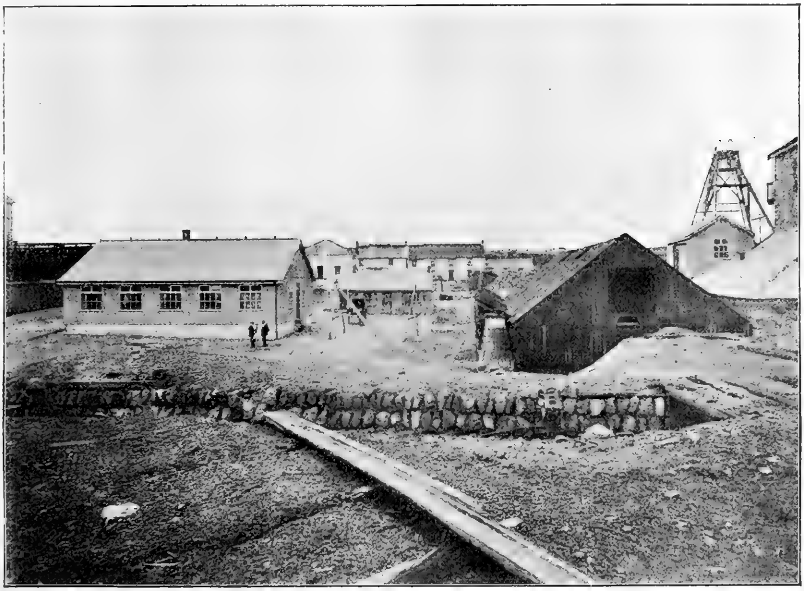
Considering that both liquid hydrogen and air are highly insulating liquids, the fact of electric discharges taking place under such conditions proves that the electric potential generated by the cooling must be very high. When the cooled crystal is taken out of either liquid and allowed to increase in temperature, the luminosity and electric discharges take place again during the return to the normal temperature. A crystal of nitrate of uranium gets so highly charged electrically that, although its density is 2·8 and that of liquid air about 1, it refuses to sink, sticking to the side of the vacuum vessel and requiring a marked pull on a silk thread, to which it is attached, to displace it. Such a crystal rapidly removes cloudiness from liquid air by attracting all the suspended particles on to its surface. The study of pyro-electricity at low temperatures will solve some very important problems.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Education Bill has been abandoned by the Government on account of want of time to consider it adequately during the present session. A short measure dealing with the difficulties which have arisen in connection with the recent judgment as to higher elementary schools and evening continuation schools was introduced in the House of Commons on Tuesday, and it is hoped that the second reading will be taken early next week. The measure proposes to empower county or county borough councils, or technical instruction committees, to make arrangements with School Boards for the continuation during one year of the work to which school funds have been declared to be inapplicable by the Cockerton judgment. Sir Joshua Fitch writes to the *Times* to point out that this measure is unsatisfactory, for it presupposes that a local educational authority to supersede the School Board is intended to be constituted, and meanwhile entrusts the whole responsibility of maintaining or destroying the higher elementary schools and continuation schools to the county councils, which are not necessarily conversant or in sympathy with them. These schools have been created by the School Boards, and in the case of the higher elementary schools the opportunities they give for scientific study and intellectual culture are of the highest value to national progress. What is required is a short Act of Parliament which would, for a year or two longer, leave the management and development of these schools in their present hands and provisionally legalise the needful expenditure from the rates. This, Sir Joshua Fitch remarks, "would simply postpone the controversial parts of the abandoned measure for the maturer deliberation of next session, would provide a satisfactory escape from the present *impasse*, and would, it may be hoped, encounter very little opposition."

giving practical instruction in the use of nautical instruments and in marine engineering. A building is being planned which will afford accommodation for marine engineering, naval architecture and navigation, building construction, joiner's work, and plumbing and metal-plate work, with a lecture theatre and classrooms. Practical classes will be conducted in electrical engineering, especially in connection with ships' lighting. The top floor will comprise a large room for nautical instruments and a room for cartography and the exhibition of ships' models, a chemical laboratory, a balance room, and a physical laboratory. Connected with this floor will be a flat roof on which astronomical observations may be made with such instruments as are used on board ship, and it is probable that a small dome will be provided for an equatorial telescope.

THE prospectus of the mining school at Camborne for the session 1900-1901 tells the tale of some useful educational work which is being carried on in Cornwall. The chief point, and one for which Mr. W. Thomas, the mining lecturer,



Mine Buildings of Camborne Mining School, Cornwall.

deserves great credit, is the existence of a school mine; that is to say, the school is the owner of a tin mine which is worked for educational purposes. Instead of being taught solely by lectures, diagrams and models, the student has to work below ground under the guidance of competent instructors. The school is further equipped with good chemical and assaying laboratories and a special room for teaching the useful Cornish art of "vanning," besides having a large and airy drawing office, a library and a museum. Camborne is close to Dolcoath and other large tin mines, so the student is not confined to the school mine for the purposes of instruction. The fault of the school lies in the fact of many of the lectures being delivered in the evening. Admitting the desirability and necessity of evening classes for young miners who are at work during the day, it seems hard upon the outside student, who is ready to pay full fees, that he should be made to attend lectures from 8 p.m. to 9 p.m., and even later. In the interests of the school this should be changed, even if it necessitates two sets of lectures. The accompanying illustration shows the drawing office, with the mine offices behind it; on the right-hand side

MR. J. PIERPONT MORGAN has given a sum exceeding 1,000,000 dollars for the erection of three buildings for a Harvard medical school.

THE first annual report of the Midland Agricultural and Dairy Institute has been received. The Institute has absorbed the agricultural department of the University College, Nottingham, and now provides courses of instruction in agriculture on practical lines, and calculated to gain the confidence of practical agriculturists. The work is carried on in conjunction with the county councils of Derbyshire, Leicestershire, Lincolnshire (Lindsey) and Nottinghamshire. In addition to courses of instruction for farmers' sons, the Institute undertakes analyses for farmers and conducts experiments of interest to agriculturists at selected centres in the counties named. In a small way its work is similar to that of an agricultural college and experiment station in the United States, and every assistance should be given to enable the work to be extended.

THE Technical Education Board of the London County Council is making arrangements at the Poplar Technical Institute for may be seen the "pit-head frame," with the winding pulleys, which was erected by the students.

THE Technical Education Board of the London County Council is offering facilities for boys who are leaving, or have recently left, public elementary schools to enter upon a course of training which will fit them to become gardeners. A school of practical gardening has been established at the Royal Botanic Society, Regent's Park, and is now attended by some thirty boys, most of whom are holding scholarships from the Technical Education Board. The boys at this school go through a three-years' course, in which they have a thorough training in practical gardening and also receive instruction in elementary science and botany. The scholarships offered by the Board are open to boys between the ages of fourteen and sixteen, whose parents are resident within the County of London and are in receipt of incomes not exceeding 250*l.* a year. The scholarships provide free tuition for three years at the School of Practical Gardening, and also a maintenance grant rising from 20*l.* a year to 25*l.* a year. There is no examination for these scholarships, but parents are required to sign a declaration to the effect that they intend their sons to become practical gardeners. Full particulars of these scholarships, together with application forms, may be obtained from the secretary of the Technical Education Board, 116 St. Martin's Lane, W.C. Application should be made not later than Monday, July 15.

SCIENTIFIC SERIAL.

Annalen der Physik, June.—On the parameters in the physics of crystals and on directed magnitudes of higher order, by W. Voigt.—On the change of the conductivity of salt solutions in liquid sulphur dioxide with temperature up to the critical point. Electrolytic conductivity in gases and vapours. The absorption spectra of solutions with iodine salts, by A. Hagenbach. Various alkaline salts, chiefly iodides, were dissolved in dry liquid sulphur dioxide and the conductivities measured at temperatures up to and just above the critical point. These salt solutions behave as electrolytes, even up to the critical point. The fact that polarisation occurs, shows that the electricity is conducted in the solution by means of ions. The temperature coefficients are negative between the limits of the experiments (from 20° to 160° C.), with the exception of potassium iodide, which shows a maximum of conductivity at about 90°. In the conductivity curves the critical temperature is clearly shown, although there is no absolute discontinuity at this point. Some interesting observations were made on the state of the dissolved solid when the liquid was just above the critical point, as after the meniscus had vanished the resistance of the vapour differed according as the electrodes were in the upper or lower portion of the tube, this difference disappearing immediately on shaking the tube.—On the second law of thermodynamics, by N. Schiller.—The thermodynamics of saturated solutions, by N. Schiller.—On an improved method for the preparation of photographic plates sensitive to the ultra-violet rays, by V. Schumann. A detailed description of the methods of preparing the emulsion, coating and drying the plates, exposure and development. An example is given showing the increased length of spectrum obtained with these plates as compared with an ordinary dry plate.—On a mechanical representation of the electrical and magnetic phenomena in bodies at rest, by L. Graetz.—On changes of weight during chemical and physical changes, by A. Heydweiller. Various chemical reactions were carried out in closed vessels, and in certain cases slight changes in weight were observed which, in the opinion of the author, were outside the range of possible experimental error.—Researches on electrical discharge in rarefied gases, by W. Wien.—Experiments on the influence of capillarity on the velocity of outflow of liquids, by C. Christiansen.—Communication to the knowledge of the physical properties of silver mirrors, by C. Grimm. A study of the electrical resistance of thin silver mirrors under varying conditions of temperature, light, degree of polish, &c.—On a new experiment in dynamics, by V. v. Niesiolowski-Gawin.—On the behaviour of liquid dielectrics on the passage of an electric current, by E. v. Schweidler.—Stroboscopic methods for the determination of the frequency of alternation and lag of a motor, by G. Benischke.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 6.—"On the Elastic Equilibrium of Circular Cylinders under Certain Practical Systems of Load." By L. N. G. Filon, M.A., B.Sc., Research Student of King's College, Cambridge; Fellow of University College, London; 1851 Exhibition Science Research Scholar. Communicated by Prof. Ewing, F.R.S.

The paper applies the equations of elasticity to the investigation of problems connected with the circular cylinder. The solutions are symmetrical about the axis of the cylinder, and are obtained as infinite series involving circular and Bessel's functions.

The three problems treated of are as follows:—

In the first a cylinder under pull is considered, the pull not being applied by a uniform distribution of tension across the plane ends, but by a given distribution of axial shear over two zones or rings towards the ends of the cylinder.

This corresponds to conditions which frequently occur in tensile tests, namely, when the piece is gripped by means of projecting collars, the pull being in this case transmitted from the collar to the body of the cylinder by a system of axial shears.

It is found that the stress is greatest at the points where the shear is discontinuous, *i.e.* at the ends of the collar in a practical case. At these points it is theoretically infinite. For a short cylinder the tensile stress varies a great deal over the cross-section and the distortion of the latter is large.

The second problem is that of a short cylinder compressed longitudinally between two rough rigid planes, in such a manner that the ends are not allowed to expand. It illustrates the crushing of blocks of cement or stone between iron planes or sheets of millboard.

The greatest stress occurs at the perimeter of the plane ends and the "strength" is less than two-thirds of the strength under uniform compression. This result apparently contradicts the fact that the strength of stone or cement, when tested between lead plates, which allow of expansion, is very much less than when tested between millboards; but if we take into account the consideration suggested by Unwin ("Testing of Materials of Construction," p. 419) and corroborated by Prof. Ewing, that lead, which flows easily, may not merely allow, but *force* the expansion of the ends of the block, then it is shown that in tests between lead plates the strength may be much less than between millboards; moreover, such tests are indeterminate. The millboard test should give consistent results, though really introducing too large a factor of safety. The change in the form of the fracture noticed by Unwin is also confirmed by theory.

The third problem is that of the torsion of a bar in which the stress is applied, not by cross-radial shears over the flat ends, as the ordinary theory of torsion assumes, but by transverse shears over the curved surface. This corresponds to the case of a shaft or axle twisted by a frictional couple.

It is shown that the points of danger are those where the applied shear changes discontinuously. At a distance from these the solution rapidly degenerates into the ordinary type.

Physical Society, June 28.—Prof. Everett, F.R.S., vice-president, in the chair.—A paper on the effect of a high frequency oscillatory field on electrical resistance was read by Mr. S. A. F. White. The object of this paper is to discover if the action of light upon the electrical resistance of selenium can be imitated by using high frequency electrical oscillations. It is found that such oscillations permanently increase the resistance of selenium. The effect of a rise of temperature is to increase the resistance of a piece of low resistance and decrease the resistance of a piece of high resistance. The effects of the field in a piece of high resistance can be reversed by exposure to light or by reheating and subsequent cooling. In the case of tellurium a high frequency field temporarily decreases the resistance, as also does a rise in temperature. Repeated heating and cooling of a piece of tellurium permanently increases its resistance. It seems probable that all of the effects are due to rise of temperature caused by minute sparks within the mass. The rise in resistance by alternate heating and cooling may be due to the formation of tellurides with the metal of the electrodes. The large negative temperature effect of tellurium suggests that it might be usefully employed in the detection of heat radiation. The chairman expressed his interest in the paper and drew attention to the very rapid action of light upon selenium. Prof. Adams said that as the effects here noticed were not so rapid as in the case of light they were probably due to change in temperature. Prof. Bose said he had tried the effect of Hertzian radiation upon thin layers of various metals and found an increase of resistance in the case of selenium and a decrease in the case of tellurium. The effect of radiation is confined to a few layers on the surface of the conductor, but it appears that it is of the same nature in continuous solids as in coherers.—A paper by Mr. E. C. C. Baly and Dr. H. W. Syers on the spectrum of cyanogen was read by Mr. Baly. The authors have been able to obtain the spectrum of cyanogen by allowing the pure gas to flow through a vacuum tube and observing from the end of the tube. This is necessary on account of the brown deposit of paracyanogen, which renders observation in the ordinary way impossible. The spectrum obtained differs from the flame spectrum, and consists of a series of equidistant flutings through the whole of the red and yellow somewhat recalling those of the positive band spectrum of nitrogen. The experiments prove that (1) the swan spectrum is not produced by a carbon compound which does not contain oxygen; (2) the swan spectrum is that of an oxide of carbon, as it is only produced by carbon monoxide; and as this spectrum is changed at once into the carbon oxide spectrum by admission of oxygen or by intense electric discharge, and, further, as the carbon oxide spectrum is invariably given by carbon dioxide, there can be no doubt that (3) the swan spectrum is that of carbon monoxide and the carbon oxide spectrum that of carbon dioxide. Mr. Gaster said that this paper might throw light on the discussion of the arc where cyanogen, carbon monoxide and carbon dioxide are present. The presence of cyanogen might be able to explain the hissing of the arc.—The Society then adjourned until next October.

Royal Astronomical Society, June 14.—Mr. E. B. Knobel, vice-president, in the chair.—The secretary read the observations of the great comet of 1901, made at the Royal Observatory, Cape of Good Hope. The comet was first seen on April 24 by Mr. Hills, of Queenstown, Cape Colony, and rapidly became a very brilliant object, with two tails, one conspicuously brighter than the other; the fainter tail was, however, considerably the longer. Photographs taken at the Cape Observatory with a portrait lens and with the McClean 24-inch telescope were shown, and also a drawing made by Mr. Lunt, of the same observatory, which showed several smaller tails between the two main ones. The elements computed gave a parabolic orbit. Mr. Nevill, of the Durban Observatory, who was present at the meeting, said he had received a letter from which it appeared that the comet was seen in Natal the day before it was first detected in Cape Colony.—Prof. Turner gave an account of a paper by Dr. Gill on the Oxford photographic determinations of stellar parallax, and of his own reply. In the discussion which ensued the Astronomer Royal and others called attention to the various irregularities to which stellar photographs are liable.—Lord Rosse read an account of observations of Nova Persei made at the Birr Castle Observatory; further observations by Dr. Rambaut and Mr. Stanley Williams were also read. It appeared that periodical fluctuations in the light of the star (from about magnitude $4\frac{1}{2}$ to 6) still occur, though there no longer seems to be any progressive decrease in its light.—Mr. J. C. W. Herschel read his observations made at Cambridge of the Lyrid meteors.—Mr. Horner read his spectroscopic observations of the sun, made in England about the time of the total eclipse that was visible in Sumatra. He recorded an observation of a most unusually rapid disappearance of a bright solar prominence.—A paper from Prof. D. P. Todd was read, describing a mechanical device for giving graduated exposures in photographing the corona. The method was a modification of that of Mr. Burckhalter, obviating the necessity of using perforated plates.—A paper, by Dr. A. W. Roberts, on the light variations of R. Carinæ, called attention to long and short period variations of a very interesting character.

Zoological Society, June 18.—Prof. G. B. Howes, F.R.S., vice-president, in the chair.—A communication was read from Prof. Ray Lankester, F.R.S., on the new African mammal lately discovered by Sir Harry Johnston in the forest on the borders of the Congo Free State, of which two skulls and a skin were exhibited. Prof. Lankester fully agreed with Sir Harry as to this mammal belonging to a quite new and most remarkable form allied to the giraffes, but having some relation to the extinct Helladotherium, and proposed for it the generic name Okapia, from its native name "Okapi." The scientific name of this mammal would therefore be *Okapia johnstoni*, Mr. Sclater having already given it a specific name based on the pieces of its skin previously received. Sir Harry Johnston, who was himself present, gave an account of the facts connected with his discovery of this animal. Sir Harry also stated that during his last excursion to the north of Mount Elgon he had found large herds of a giraffe in this country which appeared to be distinct from previously known forms of this mammal in having five bony protuberances on the head, four placed in pairs and one anterior in the middle line. Four examples of this animal were now on their way home, and would soon be here to settle the validity of this presumed new species.—The Hon. W. Rothschild, M.P., exhibited and made remarks upon specimens of a mounted male and two unmounted males and a female of the rare Abyssinian goat (*Capra walie*, Rüppell), and of a mounted male of the Abyssinian wolf (*Canis simensis*, Rüppell), which had been obtained by Captain Powell-Cotton during his recent visit to Abyssinia.—Mr. Oldfield Thomas exhibited a pair of antlers which had been sent home by Mr. Charles Hose, who had obtained them from Central Borneo. They appeared to differ from the antlers of all other known deer in being highly complicated and many-branched, with the upper portion curved forward, and the brow-tines developed into broad horizontal paddle-like structures. From this character it was proposed to term the species *Cervus spatulatus*.—Mr. R. Shelford exhibited a series of lantern slides, exemplifying mimicry amongst Bornean insects, especially amongst the Longicorn division of the Coleoptera.—A communication was read from Mr. J. E. S. Moore containing an account of his recent researches on the mollusca of the great African Lakes.—A communication from Captain H. N. Dunn contained field notes on eight species of antelopes, specimens of which he had met with during his recent sojourn on the White Nile in connection with the "Sudd" expedition.—A communication was read from Dr. R. Bowdler Sharpe on the birds collected by Dr. Donaldson Smith during the early part of 1889 in Northern Somaliland. Specimens of 103 species were contained in the collection.—A communication from M. Constantin Saturnin contained a description of a new species of hedgehog from Transcaucasia, proposed to be named *Erinaceus calligoni*. To this was added a revision of the species of the genus Erinaceus of the Russian Empire.—A communication was also read from Mr. J. Lewis Bonhote on the evolution of pattern on birds' feathers, in which it was attempted to show how all the various patterns on the feathers had been derived from a common origin, and were passing or had passed through a definite series of stages before reaching the shapes in which they were found.—Mr. J. Cosmo Melvill read the first part of a paper prepared by himself and Mr. Robert Standen, entitled "The Mollusca of the Persian Gulf, the Gulf of Oman and the Arabian Sea, as evidenced mainly through the collections made by Mr. F. W. Townsend, of the Indo-European Telegraph Service, 1893–1900." The area embraced was determined by an imaginary line (for which reasons were given) drawn obliquely from Cape Ras El Had, below Maskat (lat. 22° 50′ N.), and Panjim, India (lat. 16°). This was the first attempt towards a complete catalogue of the mollusca of this region, between 900 and 1000 species being named, of which more than one-third were of very restricted distribution.

Mineralogical Society, June 18.—Dr. Hugo Müller, vice-president, in the chair.—Mr. Alfred Harker gave a simple proof of the anharmonic ratio of four faces in a zone.—Mr. William Barlow, in continuation of his work on the partitioning of space on the principles of closest packing, exhibited models which presented accurately the symmetry displayed by potassium-alum. The symmetry of various tetartohedral minerals was also explained by the twist which must be given to certain groups of atoms in order to make the packing as close as possible.—Mr. Herbert Smith, in continuation of an examination of crystals of calaverite, showed by means of a gnomonic projection the extremely intricate character of the crystals. The general form suggests monoclinic symmetry, and a well developed face perpendicular to the prism edge frequently occurs; but the symbols which on this supposition must be assigned to the faces are, with few exceptions, very complicated. The majority of the faces lie on a lattice with triclinic symmetry, and of the remainder the majority lie on another lattice inconsistent with the former.—Mr. G. T. Prior pointed out the isomorphous relations between sulphates and orthophosphates as exhibited in a group of rhombohedral minerals, including hamlinite, $AlPO_4.SrHPO_4.Al_2(OH)_6$; florencite, $AlPO_4.CePO_4.Al_2(OH)_6$; beudantite, $Fe'''PO_4.PbSO_4.Fe_2(OH)_6$; svanbergite,

$$AlPO_4.SrSO_4.Al_2(OH)_6;$$

alunite, $AlSO_4KSO_4.Al_2(OH)_6$; and jarosite,

$$Fe'''SO_4KSO_4.Fe_2(OH)_6.$$

Similar relations are also shown by the isomorphous pairs, monazite, $CePO_4$, and crocoite, $PbCrO_4$; fergusonite, $YNbO_4$, and scheelite, $CaWO_4$; herderite, $CaFBePO_4$, and caracolite, $NaCl.PbSO_4$ (?); pharmacolite, $CaHPO_4.2H_2O$, and gypsum, $CaSO_4.2H_2O$.

PARIS.

Academy of Sciences, June 24.—M. Fouqué in the chair.—Chemical equilibria. Reactions of two bases added simultaneously to phosphoric acid, by M. Berthelot. The author has studied the distribution of the bases between the precipitate and solution obtained when sodium hydroxide and calcium (or barium) hydroxide are added to a solution of phosphoric acid. A considerable proportion of the sodium is in every case found to be contained in the precipitate.—On acetylometallic radicles, by M. Berthelot. The composition of the metallic derivatives of acetylene recently described by M. Chavastelon is shown to be capable of being represented in accordance with the views formerly expressed by the author as to the presence of acetylometallic radicles in such compounds.—Synthesis of a colouring matter derived from diphenylenephenylmethane, by MM. A. Haller and A. Guyot. Crystal violet is converted by a series of reactions into the leucobase hexamethyltriamidophenylfluorene which, when oxidised with lead peroxide, yields fluorene blue, $C_{25}H_{28}N_3Cl+2\frac{1}{2}H_2O$. This colouring matter has a bluer tint than crystal violet, but does not differ essentially from the latter as regards its tinctorial properties.—A simple and trustworthy apparatus, capable of easy and rapid application, for facilitating existence and work in irrespirable atmospheres contaminated with deleterious gases, by MM. A. Chauveau and J. Tissot. The essential feature of the apparatus is an arrangement for the separation of the currents of inspired and expired air.—On globular lightning, by M. J. Violle. An instance of globular lightning was observed towards the end of a storm on June 9 last.—Action of an oxide or a metallic hydroxide on solutions of the salts of other metals: mixed basic salts, by M. Paul Sabatier. Observations on a recent paper by M. Recoura.—Third series of observations of the new star in Perseus, by M. H. Deslandres (see p. 240).—On the continuous deformation of surfaces, by M. D. Th. Egorov. Remarks on a recent communication by M. Tzitzeica.—Theory of linear groups in an arbitrary region of rationality, by M. L. E. Dickson.—On the integration of the equation $\Delta w - \mu^2 w = 0$, by M. S. Zaremba.—Chemical reactions in dissolved or gaseous systems. Vapour tension; Avogadro's hypothesis, by M. Ponsot. A continuation of previous papers on the subject, which is treated mathematically.—Capillary constants of organic liquids, by MM. Ph. A. Guye and A. Baud. The results described show that oximes and urethanes resemble alcohols, acids, ketones, &c., in being polymerised in the liquid state. The group of urethanes is remarkable in that the degree of polymerisation *increases* with the molecular weight.—On the preparation of phosphorous oxide, by M. A. Besson. Fresh experiments are cited in proof of the existence of the oxide P_2O, previously described by the author.—On the action of solar radiations on silver chloride in presence of hydrogen, by M. Jouniaux. When sealed tubes containing silver chloride and hydrogen are exposed to sunlight, metallic silver is formed, and, under favourable conditions, the whole of the hydrogen is eventually converted into hydrogen chloride.—Action of mercuric oxide on aqueous solutions of metallic salts, by M. A. Mailhe. The action of freshly precipitated mercuric oxide on the chlorides, nitrates and sulphates of manganese, cadmium, lead and iron is described. With sulphates no reaction occurs, as a rule, but the chlorides and nitrates are decomposed with the formation of mixed basic salts.—Observations on basic salts containing several metallic oxides, by M. G. André. A number of complex salts were described by the author some years before the recent experiments of MM. Mailhe and Recoura.—Action of bases and acids on the salts of amines, by M. Albert Colson. Former experiments on this subject are continued.—On racemic erythritol, by MM. L. Maquenne and Gab. Bertrand. Griner's experiments are confirmed and extended. The four theoretically possible stereoisomeric erythritols are now known.—Action of acid chlorides on aldehydes in presence of zinc chloride, by M. Marcel Descudé. The action of acid chlorides on aldehydes is greatly facilitated by the presence of a trace of zinc chloride.—Nitration of acetylacetic ethers and their acid derivatives, by MM. L. Bouveault and A. Bongert.—On the acidimetric value of parasulphanilic acid, by M. G. Massol. A thermochemical paper.—On racemism, by MM. J. Minguin and E. Gregoire de Bollemont. The properties of a number of racemic camphor derivatives are compared with those of their active constituents.—Synthesis of boronatrocalcite (ulexite), by M. A. de Schulten. The artificial mineral may be obtained by adding calcium chloride to a large excess of cold, saturated borax solution, and leaving the mixture at rest for fifteen to thirty days.—On the commencement of germination and the evolution of sulphur and phosphorus during this period, by M. G. André.—Morphology of the digestive apparatus of Dytiscus, by M. L. Bordas.—On the sensibility of higher plants to the useful action of potassium salts, by M. Henri Coupin. The growth of wheat is shown to be favoured by almost infinitesimal quantities of potassium salts.—On the constitution of the seed of Hernandia compared with that of Ravensara, by M. Édouard Heckel.—Use of the Oudin resonator for the production of X-rays, by M. R. Demerliac.—On the presence and localisation of iodine in the leucocytes of normal blood, by MM. Stassano and P. Bourcet. The small quantity of iodine contained in normal blood exists exclusively in the leucocytes.—On the production of local anæsthesia in dental surgery by means of currents of high frequency and intensity, by MM. L. R. Regnier and G. Didsbury.—On the conservation of mineral waters, by M. F. Parmentier.

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THURSDAY, JULY 11, 1901.

ROTHSCHILD'S NOVITATES ZOOLOGICAE.

Novitates Zoologicae. A Journal of Zoology in connection with the Tring Museum. Edited by the Hon. Walter Rothschild, Ernst Hartert and Dr. K. Jordan.

IT has long been the custom of some of the principal museums of natural history in all parts of the world to maintain a periodical devoted, more or less exclusively, to the publication of the discoveries made by the members of their staffs and based on the collections placed under their care. The long series of *Annales du Musée* and *Archives du Musée* issued by the naturalists of the great French museum in the Jardin des Plantes are well known to all workers in biology. The National Museum of Holland issues its *Notes from the Leyden Museum* with great regularity, and of not less importance to zoological science are the *Annals* of the Museo Civico of Genoa. On the other side of the Atlantic, we find the *Bulletin* of the American Museum of Natural History at New York, and the similar publication of the National Museum of the U.S. at Washington, both mainly devoted to the work performed by the naturalists of those institutions, and in South America the Museums of Parà and S. Paulo issue corresponding publications. One advantage of this plan is that it helps to make the existence of the museum and its working staff more generally known, and another that it supplies a convenient medium for the exchange of publications with other similar institutions.

Shortly after Mr. Walter Rothschild had founded the Zoological Museum at Tring, in order to house his large collections, and to render them more accessible for scientific research, he wisely determined to establish an illustrated periodical for the publication of the results of his own work and that of his fellow-labourers in the new institution.

Novitates Zoologicae is the appropriate title of this "organ," and quite deserves its well-chosen name. Beginning in 1894, it has now completed its seventh annual volume; and the eighth (for 1901) is in full swing. But before we speak of the contents of this work, a few words may be said about the building in which Mr. Rothschild's treasures are housed, and which stands in a quiet corner of the little town of Tring on the borders of Tring Park. Lord Rothschild's son has been from early youth a devoted student of natural history of all kinds, and has well employed his almost unrivalled opportunities for hunting up new and rare specimens in every quarter of the globe. Active agents under his directions have explored the mountains of New Guinea, the little-known islands of the Northern Pacific, and the forests of South America with great success, and have reaped a large harvest of zoological specimens which have accumulated under his care. After the collections thus made had outgrown the accommodation that could be given to them in a private establishment, Mr. Rothschild determined to establish a building for their special reception. This was accomplished about 1891, when a museum, plain in structure, but admirably adapted to its object, arose, under Mr. Rothschild's directions, at the corner of Tring Park, and has since that period become famous amongst naturalists as the "Zoological Museum, Tring."

The Tring Museum consists of two departments—the public galleries and the working laboratories. The galleries contain a fine series of mounted specimens illustrative of all the leading orders of animals and admirably mounted and arranged for the edification of the general public, who are admitted to inspect Mr. Rothschild's treasures four days in the week. Mammals, birds, reptiles, fishes, insects, shells, corals, sponges and other marine animals crowd the shelves, and amongst them are many specimens of special interest on account of their rarity or remarkable forms. The mammals and birds of the British islands are specially attended to, and a cabinet of glazed drawers, accessible to every visitor, contains a nearly complete series of British butterflies and moths, which renders the identification of these insects easy to the inquirer. Amongst the rarities in the order of mammals is a stuffed specimen of the extinct quagga (*Equus quagga*), one out of the four or five still known to exist in European museums. Another nearly extinct mammal well represented at Tring is the white or square-mouthed rhinoceros of South Africa (*Rhinoceros simus*). Two of the few remaining examples of this huge animal were shot in Mashonaland by Mr. R. T. Coryndon in 1892. One of these is now in the British Museum, while the other was secured by Mr. Rothschild. The specimen in the Tring Museum, which has been splendidly mounted by Messrs. Rowland Ward and Co., stands more than 6 feet at the withers, and is upwards of 12 feet in length. It is the original of the excellent figure of this species given in the Zoological Society's *Proceedings* for 1894. In the bird-series, humming-birds, parrots, game-birds, apteryxes and cassowaries are some of Tring's strongest points, whilst the set of bones of the extinct *Æpyornis* of Madagascar is unrivalled, and will strike everyone with admiration.

Such are some of the more striking objects in the public galleries of the Tring Museum, but still more important are those stowed away in the laboratories where Mr. Rothschild's naturalists, Mr. Ernst Hartert and Dr. Jordan, will be found hard at work. Mr. Hartert devotes his time mainly to birds of all classes, of which there is a splendid series at Tring. Dr. Jordan bestows his attention on the invertebrates, and especially on the lepidopterous insects, or moths and butterflies, in many branches of which the Tring collection is almost unrivalled. Both these naturalists, as well as Mr. Rothschild himself, publish most of their contributions to science in *Novitates Zoologicae*, of which we have given the title at the head of this article, although contributions are likewise made to the *Novitates* by many other specialists, to whom specimens are sent from the Tring Museum for examination and description. Seven bulky volumes of this excellent periodical have now appeared, and the eighth is in rapid progress. They are, we need hardly say, printed in excellent type and on good paper. They are also accompanied by numerous beautiful plates drawn by the best zoological artists of the day for the illustration of the special novelties described in the text.

Commencing with the first volume, which appeared in 1894, we find articles on mammals, birds, reptiles and insects of the orders Lepidoptera and Coleoptera. Fifteen coloured plates illustrate this volume, amongst which we may call special attention to that of a new lemur from Madagascar, *Propithecus majori*, drawn by Keulemans.

The second volume (1895) is nearly of the same character, and contains, amongst other rarities, a figure of the very remarkable duck *Salvadorina waigiouensis*, lately discovered in the little-known island of Waigion, the last place, perhaps, in which one would have thought of looking for a merganser. In this volume also will be found a description of some very interesting remains of the extinct gigantic bird of Madagascar (*Æpyornis*) prepared by Mr. C. W. Andrews, of the British Museum; also a beautiful figure (by Keulemans) of a new and most magnificent bird of paradise, *Astrapia splendidissima*, based on a specimen in the Tring Museum which is said to have come from the foot of the Charles Lewis mountains in Dutch New Guinea.

We need not recapitulate the contents of the following five volumes, which, however, are all of great zoological interest. But we may allude to some of the most extraordinary novelties illustrated, amongst which are (in vol. iii.) a very remarkable new Picarian bird from Madagascar, *Uratelornis chimaera*. In vol. iv. will be found figured another new and extraordinary bird of paradise, described by Mr. Rothschild as *Loboparadisea sericea*.

In vol. v. are pictures of two beautiful new tanagers, discovered by Mr. Rothschild's collector, Rosenberg, in North-western Ecuador.

In vol. vi. is given a figure of a new and gigantic tree-kangaroo (*Dendrolagus maximus*) lately discovered in Dutch New Guinea. This volume likewise contains an elaborate essay by Mr. Rothschild on the kiwis or apteryxes of New Zealand, with a chapter on their anatomy by Mr. F. E. Beddard, F.R.S., illustrated by numerous plates.

In vol. vii. (1900) will be found the conclusion of an important monograph on the butterflies of the genus *Charaxes* and the allied forms, prepared by Mr. Rothschild in conjunction with Dr. Jordan, and accompanied by numerous illustrations, which was commenced in vol. v. It will be evident, therefore, we think, that, as already stated, Mr. Rothschild has selected a most appropriate title for the organ of the Tring Museum, and has been very successful in his search for the subjects to which its pages are devoted.

THE METRIC SYSTEM.

Le Système Métrique. By G. Bigourdan. Pp. vi+458. (Paris: Gauthier-Villars, 1901.) Price fr. 10.

M. G. BIGOURDAN, of the Astronomical Observatory of Paris, has published a work with the object, apparently, of showing how leading a part France has taken in the introduction and propagation of the international metric system of weights and measures. The book, however, tells one nothing new, for cannot all it tells be found as to early history in "Base du Système Métrique" (1806, 1821); as to subsequent development in the works of Barny, Saigey, Tarbé, Leoni-Levi, the second report of the Standards Commission (1869), &c.; and as to latest scientific data in the *Proc. Verb. et Trav. et Mem. du Bureau International des poids et mesures* (Gauthier-Villars, 1875–1900)? Many of these publications are, however, difficult to obtain, and hence M. Bigourdan has met a want by putting together under one cover all available information with reference to the origin, construction and verification of metric standards.

In these days of advertisement some readers fight shy of log-rolling works, of the dishing-up of old books under new titles, of the re-editing of other men's labours, and perhaps of the literature of metric propaganda there has been enough. In the present work, however, the temptation to advertise appears to have been avoided, and the compiler has simply given, in a careful, concise and exhaustive manner, the results of the labours of the eminent chemists, physicists and mathematicians—as Arago, Benoit, Berthollet, Bertrand, Borda, Broch, Cornu, Delambre, Deville (H.), Faye, Fizeau, Foerster, Lagrange, Lalande, Laplace, Lavoisier, Stas, Tresca, &c.—who have made the metric system the only international system for all purposes.

The book contains thirty-three chapters, the first of which deals with the weights and measures in use in France previous to the revolutionary period, and to the hypotheses of Bailly and Paucton with reference to uniformity. Then follow chapters referring to the proposition of Talleyrand to the General Assembly of France in 1789; to the decrees of that Assembly in 1790 establishing a new and uniform system of measurement; and to the establishment (under the Metric Convention of 1875) of the Comité International des poids et mesures. This Comité was thus one outcome of the original proposition of 1789—a remarkable outcome generally, seeing that it changed the weights and measures of nearly the whole of Europe, and swept away native and arbitrary metrological systems which had been handed down from primitive times; systems embarrassing to scientific progress, hurtful to commerce and a tax on intelligence.

M. Bigourdan (p. 14) seems to say that in 1790 some communication was made by France to England as to the adoption of a new international base of measurement. No such communication was, however, made either through the Foreign Office or officially to the Royal Society; nor was England then invited to take part in the establishment of the metric system.

An interesting account is given by the author of the founding of the Bureau International (Pavillon de Breteuil, Sèvres, près Paris); of the construction of the new international standard of the metre, and of the kilogramme; made of platinum (90 per cent.) and iridium (10 per cent.); and which were in 1889 deposited at the International Bureau, where they are still kept. An account is also given of the verification of the étalons-nationaux, or copies of the étalons-internationaux, which have now been distributed to the high contracting states who have joined the Convention of 1875. The national standard metre and kilogramme, which were issued by the Comité to Great Britain, are referred to in the Metric Act of 1897.

With reference to the determination of the length of a linear measure, as the metre, by spectroscopic reference to rays of light, Prof. Michelson and Dr. Benoit obtained remarkable results in 1892–3.

Reference is also made by M. Bigourdan to the researches of Drs. Chappuis and Guillaume as to the mass of 1000 cubic centimetres of water at 4°. They find that a cubic decimetre of water weighs 999·936 grammes (p. 413) or 1 kg.–64 mg. Prof. D. Mendeléeff has, however, stated the mass of a cubic decimetre of water at 4° as 999·847 grammes (*Proc. Roy. Soc.*, 1896, p. 155).

The book contains seven interesting portraits of Talleyrand, Delambre and others; also an alphabetical list of more than 400 authors and persons who have taken part in the introduction and verification of metric standards, and a useful chronological table of French laws and ordinances (1557–1896).

We no longer now regard the metre as the length of 1/10,000,000th part of the quadrant of the meridian, or the kilogramme as the precise weight of a cubic decimetre of distilled water. Such derivations and definitions have proved a failure, and very much of the information set out by the author with reference thereto, although of historic interest, might well be condensed in the next edition of the book.

PROF. MAX MÜLLER'S LAST ESSAYS.

Last Essays. By the Right Hon. Prof. F. Max Müller. 1st series. Pp. vii + 360. (London: Longmans and Co., 1901.) Price 5*s.*

THE seventeenth volume of the late Prof. Max Müller's "Collected Works" contains a series of essays on language, folklore and other subjects which were selected for publication by the venerable scholar about the time that his illness assumed its last acute form; but, alas! he never lived to expand and annotate, according to his wont, such as had already appeared in print before. The greater number of them treat, as we should expect, of the subjects of which he had made a close and lifelong study, and these bear in every paragraph evidences of the clear thought and brilliant exposition which all Prof. Max Müller's readers were accustomed to expect from that expert philologist. In two of them, "My Predecessors" and "How to Work," we get a few glimpses of the man as well as of the scholar, and they cannot fail to interest all those who wonder from time to time how one man, with so many varied interests and occupations, could manage to do so much good work in a single lifetime. In "How to Work" we see the leading ideas which he kept ever before him whilst carrying on his labours of copying manuscripts, editing texts and the like, and when we read the advice which he gave to the students of Manchester College in 1896 we are able to note that we are reading the words of a man who practised what he preached. He said, "Put your whole heart, or your whole love, into your work," and "half-hearted work is really worse than no work"; it is a pity that, like the verses from the Koran which are writ large and hung up on the walls of the mosques where all men may see and read them, these excellent words cannot be copied in large letters and set before the eyes of our boys and girls in schools and colleges. Of equal value is his counsel to them to make indexes to the books that they read, and he pointed his moral admirably when he told them how he worked with slips when making his *index verborum* to his great edition of the "Rig-Veda." But then Prof. Max Müller belonged to a school which produced such scholars as Fleischer, Lepsius, Bühler, Rödiger and Hoffmann, and we cannot help doubting if their modern representatives have the inclination or can find the time to make tens of thousands of index slips. The social life of Universities, even in Germany, makes it more and more difficult for a man to devote years, or months, to tasks of this kind, and a professor finds that lectures, committee meetings, &c., use up, and alas! sometimes waste, a great deal of his time.

The essay on "Coincidences" will be read by every one who is interested in the study of comparative religion with the deepest interest, for in it is demonstrated with considerable clearness and with incontrovertible proofs, if we accept the facts set out by Prof. Max Müller, that Christianity owes much to Buddhism. The Roman Catholic missionaries Huc and Gabet, while travelling in Thibet in 1845, discovered to their horror that the Buddhist priesthood possessed the crosier, the mitre, the dalmatic, the cope, the service with two choirs, the psalmody, exorcism and prayer-beads, and that the celibacy of the priesthood, spiritual retreats, worship of saints, fastings, processions, litanies, holy water, &c., were as much the characteristics of the Buddhist as of the Roman Catholic religion. After thinking the matter over for some time the Christian missionaries made up their minds that these resemblances were the work of the Devil, who wished to lead astray any missionary who ventured to travel in Thibet, and now we know that an actual historical communication existed between Roman Catholic and Buddhist priests. It has recently been proved that the Buddhist Canon was collected at the Council held B.C. 259. at Patna by Asoka, and that the Pâli Canon of Buddhism was written down in the first century before our era, and that the Sanskrit Canon was written down in the first century after. Thus it seems clear that if any borrowing at all took place between the two religions, the Christian borrowed from the Buddhist, and not the Buddhist from the Christian. This need cause no surprise, for, apart from the well-known historical connection which existed between the Buddhists and Nestorians in the seventh, eighth and ninth centuries, there was undoubtedly frequent communication between India and Persia and Asia Minor from the time of Alexander the Great. The Buddhist religion was, like the Christian, a missionary religion, and in proof of this Prof. Max Müller has adduced some very interesting facts.

There are many other essays in the volume to which we should, if space permitted, like to call attention, and among them are those on "The Savage" and "Literature before Letters." The former was first printed in 1885 in the *Nineteenth Century*, and we cannot help thinking that had its learned author lived to see it reprinted he would have modified several sections of it; the latter is full of interest, as much for the subject of which it treats as for the indications it gives of Prof. Max Müller's extraordinary power of memory. Finally, Oxford men will read with pleasure the appreciation of the late Dean Liddell which is found on p. 314 *ff.*; and historians of modern Europe will find much information on the famous Schleswig-Holstein Question in the last essay in the volume. It is almost superfluous to add that the style in which the essays are written is clear and fluent, and we are sure that even the scientific opponents of the great Sanskrit scholar will be glad to possess in a collected and handy form some of the last writings of a man who has scored his mark broadly and deeply upon the edifice of Indian philology.

HETEROCYCLIC ORGANIC COMPOUNDS.

Die Heterocyklischen Verbindungen der Organischen Chemie. By Edgar Wedekind. Pp. iv + 458. (Leipzig: Veit and Co., 1901.) Price 12 marks.

THE author of the book before us states in his preface that his object is to extend those chapters of the elementary treatises on organic chemistry which deal with heterocyclic derivatives, to supply a text-book of the subject for the use of advanced students and the technical chemist, and thus to render unnecessary the possession of exhaustive and expensive text-books.

But, with the best will in the world, we regretfully come to the conclusion that the work is of very slight practical value; heterocyclic derivatives are frequently derived from straight chain compounds possessing complex molecules, and the chemist will find himself compelled to refer to one of those works Dr. Wedekind would avoid the use of in order to elucidate the synthesis of the heterocyclic ring.

One example of this difficulty, which may, indeed, be met with on almost every page of the book, will suffice; speaking of the methods of formation of osotriazoles, we find given as the second method: "intermolecular separation of the elements of water from the hydrazo-oximes of 1 : 2-diketones

$$\begin{array}{l} R.C{=}N.NHC_6H_5 \\ \quad | \\ R.C{=}N.OH \end{array} \quad \rightarrow \quad \begin{array}{l} R.C{=}N \\ \quad | \\ R.C{=}N \end{array}\!\!\!> NC_6H_5."$$

Now unless the student or technical chemist had made a special study of the hydrazo-oximes he would possess the vaguest idea of their method of formation, and would have to refer to a text-book. A well-known and inexpensive work of this nature ("Organische Chemie," Richter, ninth edition), under the heading α-hydrazo-oximes, describes, not only the formation of these bodies, but also, on the same page, their intramolecular condensation to the heterocyclic ring.

Dr. Wedekind has adopted an empirical classification which brings substances of most dissimilar constitution under the same heading; for example, in the group—Hetero-rings containing five members:

I. Oxygen as member of the ring.

(1) Single rings with one oxygen,

we find the following bodies, which possess slight genetic connection: furfuran, tetramethylene oxide, γ-lactones, and anhydrides of the acids of the succinic series (it is true the author announces his intention of passing over reduced and easily resolvable rings, such as anhydrides and lactones; but to be consistent, should not a reduced ring, such as piperidine, be also ruled out of court?)

Nor does Dr. Wedekind's system even possess the merit of originality; this system first appeared in the seventh (German) edition of Richter's "Organic Chemistry," and has been adhered to in subsequent editions; it was adopted by Brühl from Anschütz and Schroeter (editor and sectional editor of the above work) in his continuation of the German translation of Roscoe and Schorlemmer's "Organic Chemistry" (vols. vi. and vii.).

The genetic or rational system of nomenclature was adopted by Krafft in 1893, and is to be found, further freed from empiricism, in the last instalment of Meyer and Jacobson's "Organic Chemistry" (the group of the polynucleic benzene derivatives, 1901).

A due sense of the proportionate importance of certain classes of bodies is frequently absent; thus the very important purine group is dismissed in a few pages as an appendix to the benzopyramidine group, purines being considered as glyoxalinepyramidines.

For the rest, the book, which contains an enormous amount of information, seems carefully compiled, up-to-date and accurate; we prefer to find the references at the foot of the page instead of being collected at the end of the first and of the second part; out of 1475 references there are fifteen to English publications, which, considering the amount of work which has been done in this country on heterocyclic rings, seems scarcely a fair proportion.

In view of the facts that the ninth edition of V. von Richter's "Organic Chemistry" (Anschütz-Schroeter) has appeared, and that Messrs. Veit and Co. promise the rapid completion of Meyer and Jacobson's admirable handbook, we can only repeat that such books as the one which forms the subject of this notice are completely superfluous. W. T. L.

OUR BOOK SHELF.

The Induction Motor. A Short Treatise on its Theory and Design, with numerous Experimental Data and Diagrams. By B. A. Behrend. Pp. 105. (New York: *The Electrical World and Engineer*, 1901.)

MR. BEHREND, in the preface to his book, rather offers an apology for adding one more to the already overwhelming number of books dealing with electricity and its applications. In some cases an apology of this kind is, unfortunately, justified; but in this instance, in view of the very great importance of the subject from the electrical engineer's point of view and the increasing introduction of polyphase electrical installations, a work on the above subject, written by a writer who, from his continental experience, should know what he is talking about, is to be welcomed. The author's point of view is made clear by a quotation from Prof. J. J. Thomson, printed on the title-page: "The absence of analytical difficulties allows attention to be more easily concentrated on the physical aspects of the question . . . than if he merely regarded electrical phenomena through a cloud of analytical symbols"; and on a first glance at the book, which consists of only 105 pages, one had hoped for a concise and easily comprehensible statement of the subject. This cannot, however, be said to be the case. The book could be very conveniently entitled "A notebook for the designer of induction motors," and to an electrical engineer well versed in polyphase work it would be, without doubt, very useful. The reader who does not possess these qualifications will not find it of much value. The author admits this, in that he adds an appendix containing an extract from Gisbert Kapp's "Electric Transmission of Energy," dealing with the elementary theory of the induction motor, and says that after reading this the reader will be better able to understand his own diagrams and deductions. We think, however, that the author would have done well had he made his reasoning a little more clear and detailed. The method adopted is the graphical method, a diagram being given for each machine, &c., considered. The diagrams are given without, in some cases, any of the reasoning which leads up to them. This to the engineer who thoroughly understands the subject does not matter, and to such we would recommend the book. Besides dealing with the general calculations concerned with single and polyphase motors, one chapter is devoted to the special design of a three-phase motor of 200 h.p.; and two chapters, the first and the last, deal with the theory of the alternating current transformer. In appendix ii. a graphical method is given for integrating some of the equations given in the body of the book. We think it is possible for this so-called "non-mathematical" treatment to be carried a little too far. The electrical engineer who does not wish to be severely handicapped in his profession must be able to work out an integration without having recourse to a roundabout method to avoid it, which is most likely only applicable to the particular case under consideration.

Bulletin of the Philosophical Society of Washington. Vol. xiii. 1895–1899. Pp. xxvi + 507. (Washington, D.C.: Judd and Detweiler, 1900.)

THE subjects of papers included in this volume are:—Central American rainfall, a transcontinental series of gravity measurements, cloud classifications, steel cylinders for gun construction, the latitude-variation tide, Alaska, graphic reduction of star places, chemistry in the United States, the transcontinental arc, a century of geography, the comparison of line and end standards, recent progress in geodesy, secular change in the direction of the terrestrial magnetic field at the earth's surface, and the function of criticism in the advancement of science. In addition, there are a number of obituary notices of members of the Society.

Several of the subjects of the papers have already been referred to in these columns, and as the papers go back to March 1895, it is a little late to describe them in any detail. The volume is of particular interest to students of geodesy and physical geography, the papers on the measurement of arcs for the determination of the size and shape of the earth, and on gravity observations, being full of information. The results of a series of gravity measurements, made by Mr. G. R. Putnam, lead to the conclusion that "general continental elevations are compensated by a deficiency of density in the matter below sea-level, but that local topographical irregularities, whether elevations or depressions, are not compensated for, but are maintained by the partial rigidity of the earth's crust." Gravity measurements made on the summit of Pike's Peak and at Colorado Springs, near the base, give the value 5·63 for the mean density of the earth. A discussion of Mr. Putnam's gravity observations leads Dr. C. K. Gilbert to agree that they "appear far more harmonious when the method of reduction postulates isostacy than when it postulates high rigidity."

At the close of a paper on the transcontinental arc measured by the U.S. Coast and Geodetic Survey, Mr. E. D. Preston refers to the accuracy of the observations, and remarks: "The quality of the triangulation is best shown by a comparison of bases. The Fire Island one, nearly 9 miles long, was determined in five different ways through 1800 miles of triangulation, and the extreme range of the results is only two-tenths of a metre. The value from Kent Island base, 5 miles long and 263 miles away, only differed from that given by the Atlanta base, nearly 6 miles long and 868 miles away, by one centimetre."

The paper on the secular change in the direction of the terrestrial magnetic field at the earth's surface, by Mr. G. W. Littlehales, contains a number of valuable plates showing curves of the secular motion of the magnetic needle for twenty-nine different places.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Theory of Temporary Stars.

IN a note read before the Royal Astronomical Society on May 10, Father Sidgreaves offers a suggestion regarding the displacement of the dark bands in the spectrum of Nova Persei which seems to obviate the serious difficulty felt by astrophysicists in the explanation of the shift of the lines on Doppler's principle.

The ingenious idea set forth in this note—emanating, apparently, from so high an authority as Lord Kelvin—certainly goes far to explain the singular fact that the displacement of these dark bands in the Novæ should *always* be towards the more refrangible side. But Father Sidgreaves remarks that the suggestion does not "help us over the second difficulty: the great breadth of the bright lines, some of which seemed to have lost nothing in width up to the last days of April." The following remarks may perhaps contribute towards an explanation of this second phenomenon, and may thus form a theory supplementary to that proposed in Father Sidgreaves' note.

First of all, it ought to be remarked that the structure of the bright bands, when seen with high dispersion, is extremely complicated. In Nova Aurigæ, as well as in the present new star, the bands were observed to consist of several bright maxima separated by darker interstices. Sir Norman Lockyer, in his communication to the Royal Society on March 28, presented some exceedingly interesting diagrams, exhibiting the intensity curves of the bright hydrogen bands in Nova Persei. Sir Norman shows that these bands consisted of at least three, and in the case of $H\beta$ of even four, maxima. The very same structure appears in the chief nebula band at $\lambda = 501$, as is

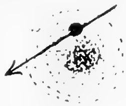

FIG. 1

shown by the measurements made with the Cooke spectroscope of this Observatory, an account of which will shortly be published.

In the note referred to, Sir Norman Lockyer has already suggested that we have here "indications of possible rotations or spiral movements of two distinct sets of particles, travelling with velocities of 500 and 100 miles per second." It appears, therefore, that the extreme width of the bright bands is not caused by a continuous broadening of the line—such as, for instance, increased pressure would produce—but by the juxtaposition of several lines belonging to the same substance, but of somewhat different wave-lengths owing to motions in the line of sight. An explanation of the width of the bright bands is thus equivalent to giving a sufficient reason for the production of displacements such as would conduce to the peculiar grouping of the maxima in the bright lines of the spectrum of new stars.

Father Sidgreaves starts from the assumption of "a collision between two stars." We shall here proceed from the hypothesis propounded by Prof. Seeliger, of Munich, that the Nova is due to the phenomenon of a dark body impinging upon and penetrating into a mass of nebular material.

Now it seems extremely unlikely that the density of the matter composing the nebula should be the same throughout. There will in all probability be a condensation of this matter round the centre, or centres, of gravity of the mass, so that the density must be assumed to decrease outwards from this centre. I consider an assumption of this kind to be warranted, if not demanded, by our modern views regarding the evolutions of stellar systems. But if a body flying through space should approach such a mass, the probability is very small that its line of motion would pass directly through the centre of gravity. Hence we are fairly warranted in assuming that the path of the body through the nebula will lie somewhere between its centre and its boundary (Fig. 1).

In such a case the friction on the surface of the body, caused by its motion through the resisting medium must be greater on the side next the centre of the nebula than on the side next its boundary. This difference of resistance must obviously result in imparting to the impinging body a rotatory movement.

Of course a tremendous translatory velocity would be required to produce any sensible motion of rotation in the impinging body itself. But by following Prof. Seeliger's reasoning it becomes easy to understand how even a comparatively small translatory motion suffices to originate enormous gyratory movements in the strata of the atmosphere surrounding the body. Obviously, the immediate consequence of a collision between body and nebula will be a superficial heating of the former and the resulting formation of an incandescent atmosphere around it. Now Prof. Seeliger has pointed out that the attraction of the body on the nebular mass through which it travels must greatly enhance the relative velocity of those particles which pass near the surface. In his opinion, "no extravagant assumption is required to obtain very great velocities for these particles, velocities such as have been proved to exist in the case of Nova Aurigæ." Hence, even when the initial translatory motion is small, the attractive force of the body would cause enormous differences of velocity between the impinging particles of the cosmical cloud and the atmosphere of the intruding body. And

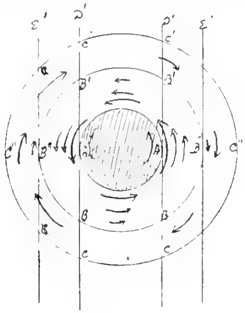

FIG. 2.

it is easy to perceive that, in case of a preponderance of impacts on one side over those on others, there must result a gyratory movement of the atmosphere, the velocity of which will, in course of time, become much of the same order as that of the impinging nebular matter.

The assumption of a cosmical cloud, the density of which increases towards the centre of gravity, leads, therefore, to the necessary conclusion that the incandescent gaseous matter near the body must assume a vorticose motion of probably very high velocity. This motion has its maximum near the surface of the body, whence it will grow less with increasing distance from the centre.

According to the fundamental laws of gyration the rotatory motion must vanish at a certain distance, beyond which it will assume the opposite direction. Let Fig. 2 represent a section through the centre of the vortex in a plane perpendicular to its axis of rotation. Let AA be the surface of the body, BB the locus of the stationary sphere separating the two oppositely-gyrating systems, CC the outermost boundary of the whole system of gyration. Then we have between A and B a rotatory motion of high velocity in *one* direction, decreasing in amount from A towards B, and a rotatory motion in the opposite direction between B and C of less average velocity than the former. The space from A to C is filled with incandescent nebulous matter, the maximum incandescence being at A, whence it decreases towards C. The space beyond C, on the other hand, is filled with nebulous matter of low temperature and no rotatory motion.

The whole vortex travels, of course, along with the central body in a certain direction. This obviously imparts to the light emitted by *every* particle of the whole system exactly the *same* displacement, and hence the motion of translation may be left out of consideration in questions dealing with *relative* velocities.

The assumption made so far, that the rotation of the particles takes place in circles concentric with the circumference of the body, must, however, be modified. The fan-like action of the body's atmosphere will draw in towards the poles of rotation quan-

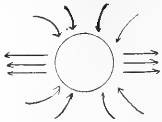

FIG. 3

tities of nebulous matter which, yielding to centrifugal force, will flow towards the equator, and be thence projected outwards again. The nature of this action may best be seen by considering a section of the system in a plane passing through the centre of the vortex and in the direction of the axis of rotation. The figure so obtained (Fig. 3) is precisely the same as that arrived at by Dr. Siemens in his ingenious theory of the conservation of solar energy. (NATURE, March 9, 1882.) In fact, the conditions postulated by Dr. Siemens in his theory—viz., that the sun is surrounded by matter in a rarefied form, filling interplanetary and even interstellar space—are precisely the conditions under which the phenomenon of a new star is here supposed to occur.

We have, then, to expect an indraught of cool nebulous matter at the poles of the intruding body, and an outflow in all directions of hot nebulous matter at its equator.

In spite of the apparent complexity of the different motions involved in the gyration here described, it is comparatively easy to indicate the influence they must have on the appearance of the lines of a substance present in the nebular matter. Let us first consider the influence of the *tangential* components of the gyratory motion.

Reverting to Fig. 2, and assuming AD to be the direction of the line of sight, it is clear that in the space AADD we have to deal with an incandescent nucleus AA whose light is intercepted by incandescent matter at a lower temperature between A and C, and by dark nebulous matter of still lower temperature between C and D. The resultant effect would be exactly that which Sir William Abney has described in *M. N.* xxxvii. p. 278. The displacements of the line in opposite directions from the normal caused by the approach and recession of the limbs of the rotating body and its atmosphere would broaden the absorption band, which would therefore appear dark in the centre and would gradually shade off towards the edges. The intensity curve of

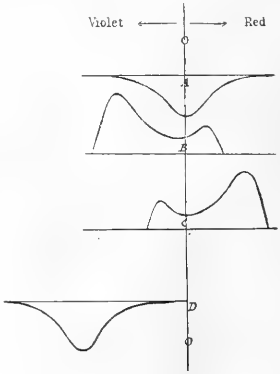

FIG. 4.

the band produced by this part of the gaseous envelope, still provided there be no *radial* motion of matter in the vortex, would thus be similar to that exhibited in curve A in Fig. 4.

Taking next the segment BAB′B″ on the left hand side of the figure, we have a motion of the incandescent nebulous matter *towards* us. We must therefore expect a bright line displaced towards the violet. The maximum intensity of this line will be near the edge farthest from the normal position, and it will gradually dim off in brightness as the normal wave-length is approached. This dimming off, which is chiefly the consequence of decreasing incandescence with decreasing rotatory motion, is enhanced by the absorbing action of the cool substance in the outer rings of the vortex. For this matter, having no motion with a direction *towards* us, can absorb only those wave-lengths which coincide with its own, viz. those emanating from the incandescent matter at and near the arc BB″B′, while it leaves the light of higher wave-lengths emanating from A unaffected.

If we now consider the conditions prevailing in the annular section BCC″C′B′, we see at once that the motion of the particles is here in the opposite direction, viz. away from the earth. The light emanating from these particles will, therefore, be displaced towards the red, and consequently a bright line must appear on the less refrangible side. But the velocity of motion in the line of sight in this annular section is smaller than at A, and the incandescence of the particles much inferior; hence the maximum intensity of this new line will not be so far from the normal wave-length, and the line will also be fainter than that on the violet side described before. Taking into consideration these circumstances, we may then assume that the intensity curve resulting from the whole radiation in the segment C′C″CA on the left hand side of Fig. 2 is approximately represented by the curve B in Fig. 4. The radiation of the corresponding segment on the right hand side of Fig. 2 must obviously be the image of B in the normal OO′, and is thus represented by C of Fig. 4.

As all the light emanating from the star must be supposed to pass through the slit of the spectroscope, the line seen in the spectrum will be the resultant of all the component curves. Clearly the character of this compound line remains unaltered, whatever position the line of sight may have with reference to the motion of the star or to the axis of gyration, except the one case when the line of sight is parallel to this axis. Obviously the band would then be reduced to a single line at normal wave-length. The probability of such an occurrence is, however, excessively small. Hence the theory here advanced would lead us to accept the peculiar character of the bright lines exhibited in the curves B and C of Fig. 4 as *a feature characteristic of the whole class of temporary stars.*

So far we have traced the structure of the line emitted by a substance of the nebulous matter on the assumption of circular rotatory movements. We have still, however, to take into account the influence of the flow of this matter to and from the centre of the vortex, as indicated in Fig. 3.

The cool matter flowing in at the poles of the vortex must be supposed to be in a non-luminous condition. It can neither radiate nor absorb selectively in the way as Kirchhoff's law would require, and hence it has no effect on the structure and position of the bright and dark bands. The hot and incandescent matter flowing out at the equator, however, has an important influence in this respect. Reverting to Fig. 2, it may be readily seen that the radial component of the motion of the gaseous particles within the space A A D D included between the two tangents to the surface of the body is directed *towards* the sun. Consequently the absorption bands caused by these particles must all appear displaced towards the violet. Thus, instead of curve A in Fig. 4, which represents the intensity of these bands when there is no radial motion, we obtain curve D of the same figure as the actual representation of the intensity of these bands in the spectrum. The striking difference between A and D is therefore the considerable displacement towards the more refrangible side of the absorption band in D. No matter what direction the line of sight has with regard to the motion of body or nebula, or whether we consider a section through the vortex at right or oblique angle to the axis of gyration, in all cases, except the one mentioned above, *the displacement of the absorption bands must be towards the more refrangible side.* The effect of the radial components of the gyratory motion on the position of the bright bands is easily seen from a consideration of the conditions prevailing in the segments C C″ C′ A in Fig. 2. Apparently there are as many motions towards as there are away from the sun. Hence the effect will consist in a general broadening of the four maxima represented in B and C of Fig. 4, without, however, affecting their position relatively to the normal wave-length.

The combination of B, C and D in Fig. 4 will therefore approximately represent the complete intensity-curve of a line emitted by a substance in the gaseous envelope of the Nova. The combination of B and C alone represents the structure of the bright bands; it agrees perfectly with the drawing given by Sir Norman Lockyer for the case of $H\beta$. Often enough the two inner maxima may overlap each other and thus produce the impression of a single strong maximum at normal wave-length. This would explain the curves with only three maxima exhibited in the diagrams of Sir Norman's paper.

There can be no doubt that the absorption band in D will partly interfere with the maximum of the emission band on the violet side. As a rule the former may be assumed to be the more refrangible, since its displacement must be enhanced by the expansion of body and vortex as a consequence of increased production of heat. In the case of Nova Persei, the difference in the displacement owing to this latter effect must have been very considerable; the two bands were here placed beside each other with comparatively little encroachment of the one upon the other. The conditions in Nova Aurigæ appear to have been somewhat different. Here the displacements of the emission and absorption bands seem to have been fairly equal, the latter obliterating the former almost completely. I consider the bright lines noticed in almost all the absorption bands of this Nova to be the remnants of the more refrangible maxima of the bright bands.

In any case the effect of a partial encroachment of the absorption band upon the emission band must be a displacement of the centre of the bright band towards the red. We therefore derive two most important results from the theoretical considerations here given:—

(1) *In all the temporary stars the absorption bands must be displaced towards the more refrangible side.*

(2) *In all the temporary stars the centres of the emission bands must show displacements towards the less refrangible side.*

These conclusions are in entire accordance with the facts. As already mentioned, an exception may happen when the line of sight is approximately parallel to the axis of gyration. In this case both the emission and absorption lines would appear in their normal positions, since all the vortex-motions are then more or less perpendicular to the line of vision. Hence the two lines would overlap each other almost completely, and the result would be a purely continuous spectrum with little or no traces of selective absorption or emission. Such an exceptional case many perhaps have presented itself to our eyes in Nova Andromedæ.

The new star in Perseus, thanks to its discovery by Dr. Anderson almost immediately after its appearance in the heavens, offered to astronomical science the unique opportunity of recording the initial stages of its development. None of the theories hitherto propounded have so far succeeded in accounting for the spectral changes so markedly exhibited in the star's light during the first days of its existence as a radiating celestial body. But just these quite unexpected and at first sight perplexing changes find a marvellously simple explanation by the modification of Prof. Seeliger's nebular theory here offered. The first effect of the collision between the dark body and a cosmical cloud must be an enormous heating of the body's surface and the generation of an incandescent atmosphere around it. The depth of this "cloak" of incandescent matter will at first be small, so that the star at that time presents the aspect of a luminous nucleus surrounded by a comparatively shallow atmosphere of incandescent gases. The spectrum yielded by such a star must be continuous, showing dark lines generated by the absorbing faculty of the glowing gases between the nucleus and space. At the moment of the outburst these dark lines will be exceedingly faint, and they will show only such a displacement as is necessary from the amount and direction of the translatory motion of the body. As time passes, however, and the gyration of the atmosphere becomes stronger, the outward flow of the hot particles must rapidly increase, and thus, in accordance with the developments given above, the dark lines, while becoming broader and more distinct, must gradually shift towards the more refrangible side. This increase in the displacement of the dark bands during the first days has been actually observed by Prof. Vogel and many other spectroscopists. To yield a *bright* line spectrum the incandescent atmosphere must have attained a considerable depth, otherwise the bright lines emanating from particles in the space CC″C′A would make no marked impression on the vividly luminous continuous background. Hence we conclude that the bright bands can only appear with sufficient distinctness when the gyratory motion has attained considerable velocity. This is exactly the sequence of the phenomena observed immediately after the outburst.

In the beginning the attracted nebular particles will impinge directly on the surface of the dark body, and hence the heat developed will mainly serve to raise the temperature of this surface. But after gyration has set in, the direct contact between the outside nebula and the body's surface is greatly lessened by the interference of the vortex. The attracted particles will then impinge upon the vortex-rings by which many of them are deflected into circular orbits and thus prevented from colliding with the surface. It is therefore conceivable that the incandescence of the nucleus, after having attained a maximum very soon after the collision, decreases again when the vortex motion gains in power. After a time, the incandescence of the nucleus will be chiefly maintained by the friction between the vortex and the surface. The star's radiation must therefore ultimately attain a lower limit where it becomes stationary so long as the vortex motion is constant. This state appears to have been reached by Nova Persei towards the middle of March.

The variability of the star is a natural consequence of this theory. We have only to suppose that the dark body, when entering the cosmical cloud, had no sensible rotation of its own. In this case the impacts would be more frequent, and consequently the incandescence more vivid, on one part of its surface than on others. Now, when the gyratory motion has become considerable, the friction between vortex and body must gradually impart a slow rotatory movement to the latter. Thus, by rotation, the patch of greater luminosity would at times be revealed to us, while at other times it would become invisible.

In conclusion I shall mention a fact revealed by the observations which speaks greatly in favour of the theoretical views set forth in this paper. Whenever the continuous spectrum of the Nova became feeble, the green band at $\lambda = 501$ was seen to gain considerably in breadth and brightness. Now a reduction of the intensity of the continuous background must obviously be accompanied by a decrease in the intensity of the absorption bands. If the nucleus were to lose its radiating power altogether, these bands would naturally become emission bands. In such a case the bright bands of the spectrum would therefore appear much broader and more intense. Hence any reduction in the general emissive power of the nucleus must tend to increase the width and brightness of the spectral lines.

That the spectrum gradually changes from the chromospheric to the nebular type is exactly what must be expected from the foregoing considerations. I need scarcely say that the theory is sufficiently flexible to adapt itself to any kind of hypothesis which may be made with regard to the physical constitution of the nebular matter. Considering the enormous forces which must have been developed in the impacts, I incline to the opinion that, besides a gaseous fluid, we are probably here in presence of cosmical matter of a meteoritic constituency such as Sir Norman Lockyer assumes in his well-known theory.

I am fully aware that the explanations I have been able to give in this communication can only be a first approach to the comprehension of a phenomenon which is necessarily one of extreme complexity. Considering, however, that the theory here advanced is based upon assumptions which seem to me perfectly warranted and highly probable, and that the prominent facts brought out by the spectroscope are satisfactorily explained by it, I venture to submit it even in this preliminary state to the criticism of astronomers. It is certainly the first time that the ingenious theory of Dr. Siemens has been called upon to explain a phenomenon in the remote recesses of the universe, and I am confident there must be many admirers of this eminent man of science who would wish to find his excellent theory applicable to the extraordinary case of stellar evolution before us.[1]

My best thanks are due to Mr. G. Clark, of this Observatory, for several suggestions which proved to be most valuable for the above investigation.

J. HALM.

Royal Observatory, Edinburgh, June.

[1] It is worthy of remark that a terrestrial cyclone, if the velocities therein exhibited were vastly greater than they actually are, and if its centre were occupied by a radiating nucleus so hot as to make the gyrating gases incandescent, would present to an outside observer exactly the same structure in the bands of its spectrum as is exhibited in the case of Nova Persei.

Vitality of Seeds.

THE resistance of the dormant protoplasm of seeds to low temperatures has lately received much attention. C. de Candolle, Pictet, Brown and Escombe and Sir W. T. Thiselton-Dyer have in succession extended our knowledge of the resistance of seeds towards extremely low temperatures. The last-mentioned experimenter has shown that very various seeds do not lose their germinating power after being exposed to the temperature of liquid hydrogen.

The upper limit of temperature which seeds can resist does not seem to have been carefully ascertained. It is probable that it would vary with different seeds and for the same seed when containing different percentages of water. For it is known that the coagulating point of proteid depends, within certain limits, on the amount of water present in it. Thus Lewith (*Arch. für exp. Pathol. u. Pharmak.* 1890) showed that proteid containing 25 per cent. of water coagulates at 74°–80° C., containing 18 per cent. at 80°–90° C., and with 6 per cent. only at 145° C. It follows that if it is the coagulation by heat of the proteids of the seed which prevents the embryo returning from its state of suspended animation into active vitality, the resistance of the seed will depend on its state of desiccation.

With this idea I have been making a few preliminary experiments on desiccated seeds, and I find that in every case they can resist surprisingly high temperatures. At first I thought it necessary to desiccate the seeds over sulphuric acid for a fortnight or longer before raising their temperature considerably. I now find it as effective, and more convenient, to dry the seeds on an oven for a day at 65°–75° C., and then for a day at 90° C. After this they may be raised to successively higher temperatures without harming them till their upper limit is passed. All the seeds I have tested can resist a temperature of at least 100° C. The following are the species I experimented with:—*Avena sativa*, *Lolium perenne*, *Lactuca sativa*, *Helianthus argophyllus*, *Mimulus moschatus*, *Medicago sativa*, *Brassica Rapa*, *Eschscholtzia californica*, *Papaver somniferum*, *P. nudicaule*, *Meconopsis cambrica*, *Schizopetalon Walkeri*.

Of these Medicago has proved the most resistant. After an exposure of one hour to 110° C. and then of one hour to 121° C., 10 per cent. germinated.

The effect of exposure to the high temperature is, however, noticeable in all cases by the marked retardation of germination and by the extremely slow growth afterwards. The young plants, too, seem weakly, and there is a distinct loss of sensibility to the geotropic stimulus in their radicles. Whether they would ultimately become normal I cannot say, as the conditions under which they were germinated were not suitable for further development.

For most of the other seeds the upper limit seems to be considerably lower. It lies about 110° C. Perhaps, however, by more careful desiccation even these less resistant ones may be brought into a condition to stand exposure to higher temperatures. The following table will convey some idea of these preliminary experiments, showing the upper limit and the retarding effect of exposure to high temperatures for each species.

The Roman numerals indicate the number of days between moistening and germination as indicated by the protrusion of the radicle.

Temperatures	15°	97°	100°	105	107°	108°	110°	112°	114°
Avena sativa	iii	vi	v	iv	—	—	xi	—	—
Lolium perenne	v	iv	iv	v	xii	—	xii	—	—
Lactuca sativa	ii	ii	ii	ii	vi	—	viii	xii	xviii
Helianthus argophyllus ...	iv	iii	iii	iv	xi	—	xi	—	—
Brassica Rapa	ii	ii	—	iii	vi	vi	viii	—	—
Eschscholtzia californica...	ii	iii	ii	ii	ii	—	vii	—	—
Mimulus moschatus ..	—	vii	ix	xviii	—	—	—	—	—

From this table the increase in the time needed for germination is apparent. All the samples of seeds were sown on moist sand simultaneously, and maintained under conditions of temperature and moisture as similar as possible.

For the other seeds not mentioned in this table the time needed for germination was not recorded, and only the maximum temperature resisted was observed. These maxima were as follows: *Schizopetalon Walkeri*, 105°; *Papaver somniferum*, 100°; *P. nudicaule*, 100°; *Meconopsis cambrica*, 100°; *Medicago sativa*, 121°.

This great resistance of dried seeds to comparatively high temperatures naturally calls to mind Prof. Giglioli's most remarkable experiments with regard to the actions of poisons, both gaseous and liquid, on seeds. An account of them was given in NATURE, 1882, p. 328, and 1895, p. 544. He found that dried seeds of *Medicago sativa*, although exposed to the prolonged action of gases such as oxygen, chlorine, nitric oxide, &c., and of poisonous fluids, *e.g.* alcohol, corrosive alcohol, &c., retained their power of germination. In some of his experiments the time of immersion of the seeds in the poison was so prolonged (many years) that the supposition of the non-penetration appeared precluded. I have repeated Giglioli's experiments with several species, and found, as he did, that some seeds can withstand the action of poisons while others cannot. Seeds of *Medicago sativa* were exposed from 10–30 days to the action of methylated spirit, spirit saturated with mercuric chloride and with picric acid without their powers of germination being noticeably affected. Similarly, seeds of *Papaver Rhoeas*, *P. somniferum* and *Schizopetalon Walkeri* resisted the action of spirit, but were apparently killed by corrosive alcohol. *Papaver Rhoeas* germinated after two days' immersion in chloroform and two days in spirit. On the other hand, seeds of *Nicotiana Tabacum*, *Linaria reticulata*, *Gypsophila paniculata* and *Calandrina umbellatum* did not germinate after immersion in spirit.

The following experiment shows, I think, that this astonishing resistance to poisons is not due to the quiescent state or stability of the protoplasm of the seed, but to the imperviousness of the seed-coat. A large number of seeds of *Medicago sativa* were taken, and half of them were punctured with the prick of a needle. All were then desiccated, and after desiccation immersed some in spirit, some in spirit and mercuric chloride and some in spirit and picric acid. It was then found that the intact seeds germinated in large quantities even after immersion in the poisonous fluids, while the punctured seeds germinated in no case after immersion. In a control experiment it was found that the punctured seeds both before and after desiccation germinated freely. It would appear, then, that when the penetration of the poison was secured the effect was to destroy the vitality of the seed.

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An Instance of Adaptation among the Deer.

MY friend Major C. S. Cumberland has just brought from Manipur the head and hind-foot of a deer, the latter of which affords an interesting instance of adaptation to environment. The deer in question is the Manipuri representative of the thamin (*Cervus eldi*) of Burma, an animal inhabiting open tree jungle. The Manipur valley is, however, a huge swamp, and the thamin of that locality have developed a peculiar modification in the foot which enables them to walk with ease in such ground. In the Burmese thamin the under surface of the hind pasterns is covered with hair in the ordinary manner, and the animal walks entirely on the main hoofs, keeping the pasterns much elevated. In the Manipuri thamin, on the other hand, the under surface of the pasterns is covered with a hard, horny, bare skin, which immediately above each hoof has almost the consistency of horn, and is practically continuous with the hoof itself. Moreover, so far as can be determined from comparison with a mounted specimen of the Burmese form, the pasterns are very considerably longer than in the latter. In walking, according to the account given by Major Cumberland, the foot is much bent, so that the animal walks on nearly the whole of the under surface of the pasterns, and thus gains a firm support on the yielding morass.

Assuming this feature to be constant (as Major Cumberland believes to be the case), the Manipuri thamin appears entitled to rank as a distinct local form, for which the name *C. eldi cornipes* will be appropriate, Major Cumberland's specimens standing as the type.

But, quite apart from this minor point, the specimens are of especial interest as showing a previously unknown mode by which ruminants may adapt themselves to a life in swamps. In the well-known instance of the sitatunga antelope of Africa a sufficiently large surface of support is afforded by a lengthening of the hoofs; in the present case the hoofs remain of the normal length, and support is obtained by the animal walking on the under surface of the pasterns, which is specially hardened. It is, in fact, an incipient instance of the reversion of a digitigrade animal to the plantigrade progression of its swamp-dwelling ancestors.

R. LYDEKKER.

Snow Conditions in the Antarctic.

THE meteorologist of my expedition has unfortunately given a somewhat incorrect idea about the snow conditions at Cape Adare. He reports, namely, that there is a very small snow fall at the sea-level. This is, in my opinion, not the case. But his mistake is excusable and easily explicable; of course, being a young Tasmanian and not previously having seen ice and snow, a devotee to his instrument, took down in his note book the evidence of a usual snow gauge. Snow seldom or never fell in the Antarctic except during heavy gales, and it must be clear to anybody familiar with snow that a snow gauge of the ordinary type is worse than useless during heavy gales. Although Cape Adare itself and the peninsula on which we lived were almost free of snow in the open, we had more than ten feet of snow to the leeward of our hut at Camp Ridley, and undoubtedly there would have been still more had the huts been higher. This indicates, of course, that much snow fell, but it was blown away as well from the promontory at Cape Adare as from the unfortunate snow gauge. In my opinion a very heavy snow fall takes place within the Antarctic circle. And I believe that the strong gales within the Antarctic circle generally are local and that these snow bared dark promontories are the very homes of the Antarctic gales, while those places where no dark land is to be seen probably are unmolested by great atmospheric disturbances and are therefore covered in heavy snow. From time to time in the pack ice I have passed through distances where the ice was covered in several yards of loose snow. This I noticed as well on my first voyage in 1894 as during my last expedition. I will therefore use the opportunity to warn the coming expeditions from not providing against the difficulties which a very heavy snow fall incurs for sledge parties within the Antarctic circle.

C. E. BORCHGREVINK.
(Commander British Antarctic Expedition, 1898-1900).

Douglas Lodge, Bromley, Kent, July 6.

PHOTOGRAPHIC AND PHOTOMETRIC SURVEYS OF THE STARS.[1]

EVERYONE will naturally wish to offer words of hearty congratulation to Sir David Gill and his able coadjutor, Prof. Kapteyn, on the completion of the Cape Durchmusterung, of which the third and last volume has recently appeared. Some twenty years since, when the capacity of celestial photography was practically an unknown factor, Sir David Gill proposed to himself to complete a survey of the southern hemisphere by means of photographic star maps. The original conception was a tolerably modest one. Sir David Gill's idea was simply to prepare from these maps a working catalogue of stars to facilitate the meridian zone observations, after the programme of the Astronomische Gesellschaft, but "to avoid the repetition of such an arduous undertaking as Argelander's Durchmusterung as a preliminary step." How the original plan was extended and grew, till the results fill three bulky volumes, exceeding Argelander's work both in number of stars and in accuracy of observation, he has himself told in the introduction to the first part, to which we have already referred (NATURE, vol. lvii. p. 513). Very rapidly has the work gone on once all preliminary difficulties were removed, and now the astronomers of the Cape and of Groningen see their work completed on a uniform plan within a moderate space of time, with an accuracy which approaches that attaching to the older so-called "Precision Catalogues," together with the means existing for the determination in special instances of star places with even greater accuracy. For though we have spoken of the completion of the work,

[1] "The Cape Photographic Durchmusterung for the Equinox 1875." By David Gill, C.B., LL.D., F.R.S., &c., His Majesty's Astronomer at the Cape, and J. C. Kapteyn, Sc.D., &c., Professor of Astronomy at Groningen. Part iii. Zones −53° to −89°. Pp. 88+671. (Edinburgh: Neill and Co., 1900.)

"A Photometric Durchmusterung, including all Stars of the Magnitude 7·5 and brighter North of Declination −40°, obtained with the Meridian Photometer during the Years 1895–98." By Edward C. Pickering, Director of the Harvard College Observatory. Pp. 330. (Cambridge, U.S.A., 1901.)

this is to be understood in a limited sense. The discussion of the catalogue is about to begin. Such discussion will include the examination and detection of errors in the "Precision Catalogues," the search for, and discovery of, stars with large and unsuspected proper motions, and the formation of a catalogue of variable stars for the southern hemisphere. Further, the course of the work has disclosed the existence of a possible systematic difference of colour in stars, depending on the galactic latitude, and intimately connected with this inquiry is the investigation of the systematic corrections which should be applied to the magnitudes derived from the Cape plates to ensure one uniform system, photographically considered, or to connect the photographic and optical magnitudes. A revision conducted on such ample lines is a task of only less magnitude than that of the construction of the catalogue itself, while the importance and interest are even greater. That the same competent hands will carry such a discussion to a final issue will be the hope and the expectation of all astronomers.

The introduction supplied by Prof. Kapteyn to the third volume cannot possess the novelty and the interest which naturally attaches to that accompanying the first volume of the annals. In that it was necessary to detail his scheme of measuring the plates and effecting the reduction; he also sketched the results at which he had arrived by comparison with the work made on the meridian by other astronomers, pursuing similar but less extensive methods. The subsequent volumes have had to record the mechanical accumulation of the places and magnitudes of stars observed by the same method, till we have piled up for us the enormous total of 454,384 stars, catalogued within an area of 13,911 square degrees, embraced in the district between the South Pole and the parallel of 19° south declination. The greater richness of the southern skies is shown by the fact that this number is only slightly less than that contained in the joint Durchmusterung of Argelander and Schonfeld, extending from the North Pole to 23° south declination. Further, this richness has increased as the observations have been carried polewards, the maximum being reached in the zone 48°–58° S. decl. In the first section, comprising the zone 18°–37° S. decl., the average number of stars to a square degree was 25·43 (Nature, *loc. cit.*); for the whole the average number is 32·66, or more than double that of the Northern Bonn Durchmusterung. But in a discussion involving relative density of aggregation the vexed question of the maintenance of a uniform standard of magnitude throughout the whole survey enters with perplexing uncertainty. On this point Prof. Kapteyn entertains views into which we do not care to enter too minutely, for we are yet awaiting his complete answer to sundry criticisms which have been advanced. We are certainly inclined to follow him in his assertion that if two or three tenths of a magnitude be deducted from the estimates we shall obtain the limit of photographic magnitude to which the stars of the catalogue are certainly practically complete, and that consequently we may assume the whole catalogue to embrace all stars down to 9·2 mag.

There is, however, the other and more thorny question, which touches on the relative chemical activity of stars in different parts of the sky, which it is not so easy to answer. Prof. Kapteyn puts the question thus. To what limit of magnitude would the plates be found complete were the magnitudes of the Cape Durchmusterung reduced to a homogeneous set of photographic magnitudes for the whole sky? The answer which he offers is that the Durchmusterung will be found practically complete in or near the Milky Way, to stars which in the scales of Schonfeld, of Gould and of Thome are of the magnitude 9·5, and for the rest of the sky to stars actinically equivalent to these. The vagueness of this reply is due to the peculiar feature that Prof. Kapteyn's discussions have disclosed, and whose complete explanation is not yet forthcoming. The measurement of a great number of plates has satisfactorily shown that the law expressing the growth of star density depending on proximity to the Milky Way differs essentially from that exhibited in the optical observations of Schonfeld and Gould. For this fact two explanations, equally plausible, can be offered. Prof. Kapteyn's contention is that there is a real difference in the colours of the stars as the Milky Way is approached, and that the increase of blueness leads to increasing discrepancies in the differences between photographic and visual magnitude, amounting roughly to 0·01 mag. for each degree of galactic latitude. On the other hand, the ground for the observed inequality may be due to systematic errors in assigning the optical magnitudes to stars under the different condition in the method of selection of the stars, when they pass slowly in the sparser regions of the sky, and when the richer regions are being observed. The tendency might very well be, from the greater time at the disposal of the observer in the first case, to observe fainter stars than when he finds his field crowded with passing objects. Of course, both views were fully admitted by Prof. Kapteyn, but he considered he had sufficient evidence to establish his case, and though he acknowledges the force of the arguments which have been brought against him, he is still inclined to maintain his view. The fuller discussion is one of those points which have been left for future investigation so as not to delay the completion of the main work, but if the Groningen astronomer can obtain support for his theory it may have an important bearing on our views concerning the cosmical arrangement of the stars.

The accuracy of the stars' coordinates remains practically the same as in the earlier volumes, and from a comparison with Gould's meridian places may be given as follows:—

Declination.	Prob. Error in Right Ascension.	Prob. Error in Declination.
$-38°$ to $-58°$	$\pm 0^s{\cdot}288$	$\pm 0'{\cdot}0444$
$-58°$ to $-86°$	$\pm (0^s{\cdot}157 + 0^s{\cdot}0764 \sec \delta)$	$\pm 0'{\cdot}0559$

But the method of measurement of stars on the polar plate affords a better means of determining the degree of accuracy attainable on these plates, and of the possible service they are likely to render in settling questions of identity or of proper motion. On this plate the rectangular coordinates have been measured with the Repsold apparatus acquired by the astronomical laboratory at Groningen, and the measures reduced by comparison with all the stars (save one) common to the plate and to Gould. Making due allowance for proper motion and error of observation in the Cordoba places, the probable errors of the Cape positions are found to be in R.A. $\pm 0''{\cdot}53$ (arc of great circle); in decl. $\pm 0''{\cdot}76$.

Considering the shortness of the focal length (54 inches) such a result is extremely gratifying, and it seems likely, as anticipated by the authors, that many questions connected with the proper motion of the southern stars can be at once set at rest by an appeal to the original plates. Some such work seems to have been already begun, judging by the tables added to the volume, in which are shown instances of stars missing on the plates and yet given elsewhere, and of stars found on the plates not recorded in known catalogues. Such work requires infinite patience and care, and we can only once more congratulate the joint authors on the success that has attended their unwearied efforts to secure uniformity and accuracy.

The second work under notice also exhibits the results of continued labour pursued with persistence and success. Photometry has so long been a feature in the researches at Harvard College Observatory, and so many successive volumes have detailed the method of observing, that on the present occasion the Director contents himself with a very short preface, but which gives evidence of the same untiring energy which marked the earlier volumes. For example, we are told that between 1891 and 1898 no less than 473,216 photometric settings were made with the meridian photometer, nearly all by the Director himself. The object of this heavy undertaking was to determine the magnitude of all stars brighter than 7·5 situated north of $-40°$ declination. In the early days of magnitude work the Director did not propose to pass the limit of $-30°$. This restriction was perhaps necessary on account of the smaller photometer employed, but to overstep it may also indicate that the Director feels himself now competent to cope with the difficult questions arising from the extinction of light in our atmosphere. For, although the Durchmusterung does not aim at completeness beyond $-40°$, a good many stars, reaching to even within one degree of the Harvard horizon, have been included. Such measures are necessarily frequently discordant among themselves and do not agree with the estimates made in the southern hemisphere, but the discussion of all the discordant residuals, from whatever source arising, is deferred till the appearance of another volume. A difference of 0·65 mag. from the mean has been selected as marking the limit of discordant measures.

It will be noticed that this photometric survey covers no inconsiderable portion of the area that has been examined by Kapteyn. The whole of the first volume of the Cape Durchmusterung, $-18°$ to $-37°$, is included, and should therefore furnish at once enlarged material for the examination of the systematic differences between photographic and visual magnitudes. Further, the meridian Pickering photometer is at present at the Arequipa Observatory, having been dismounted in September 1898, and the energetic Prof. Bailey is presumably using the same instrument at the southern station. Care has been taken to interchange the observers at Harvard so as to supply the means of reducing the observations on a uniform system, and thus continuing the Harvard survey to the Southern Pole. We may therefore look forward to the rapid acquisition of further data which will not only afford better values for the constants of reduction of the Cape plates, but exhibit in an unmistakable manner, though it may not solve, the perplexing difficulties to which we have alluded. Certainly, if energetic prosecution of the observations is of avail, the matter could not be in better hands than those of the Directors of Harvard and the Cape Observatories. W. E. P.

THE TREATMENT OF DISEASE BY LIGHT.

PHOTOTHERAPY, or the treatment of disease by light, has now, thanks to Prof. Finsen of Copenhagen, a recognised place in the domain of therapeutics. Finsen's first paper on the subject was published in 1893. In it he showed that the chemical or ultra-violet rays of the spectrum have a definite effect upon the course of small-pox, and he proposed that patients suffering from this disease should be kept in rooms from which the chemical rays of light were excluded by means of red curtains or red glass, in the same way that a photographer excludes these rays from his plates and paper. In an ordinary case of small-pox treated under the usual conditions, the eruption passes from the vesicular to the suppurative or pus-forming stage, and this condition is most marked upon the face and hands, the parts most exposed to light. It is in consequence of the destruction of the skin attendant upon the suppuration that the face and hands are so commonly the seat of hideous scars. Finsen's suggestion has been carried out with considerable success. In nearly every case in which the patient was kept in red light from the onset of the disease, there has been found to be a marked change in the course of the eruption. The suppuration and its attendant secondary fever have been almost, if not entirely, abolished, and as a result the patients recover with little, if any, scarring.

Finsen's next researches were made upon the action of light as an irritant, and they are of extreme interest to the biologist. It will suffice here to say that he found that the animal organism, especially in creatures which prefer to dwell in the dark, is markedly irritated by the chemical rays, while the other parts of the spectrum are non-irritant. From this he was led to investigate the effects of light upon bacteria. Here the field had already been occupied by Downes and Blunt, who, in 1878, in a paper read before the Royal Society, showed that the chemical rays are bactericidal. Duclaux, Arloing and others have worked upon the same lines and confirmed their results. It therefore seemed probable that superficial diseases of the skin caused by bacteria could be cured by the application of light. Of these, one of the most important and most intractable is lupus. Finsen, however, argued that the intensity of ordinary sunlight is obviously insufficient to kill the microbes as they lie in the skin, for lupus is particularly a disease of the face, which is more exposed to the sun than any other part. He therefore tried the effect of concentrating the light by means of lenses, cutting out the red and ultra-red rays by a blue medium. He found that cultures of micro-organisms *in vitro* were much more powerfully influenced by the concentrated rays. The sun's rays concentrated by the apparatus to be presently described were fifteen times stronger than ordinary sunlight. Powerful electric arc lights were also tried, and with a lamp of from 35 to 50 ampères the effect was similar to that of the sun, or even greater.

The next point to be determined was the penetrative power of light. For this purpose small sealed tubes containing silver salts were placed under the skin of animals and exposed to the concentrated light, and the silver was found to be blackened.

The effect of the blood circulating in the tissues was next demonstrated by a very ingenious experiment. A piece of photographic paper was placed behind the ear, and the outside of the lobule was exposed to the light. In about five minutes the paper was blackened. The experiment was then tried with the ear compressed between two pieces of glass so that it was rendered bloodless. The photographic paper was blackened by the light in twenty seconds. The absence of the red colouring matter of the blood allowed the chemical rays to penetrate with great ease.

The apparatus devised by Finsen for the treatment of lupus by the sun's rays (Fig. 1) consists of a large hollow planoconvex lens, filled with an ammoniacal solution of sulphate of copper and mounted upon a fork-like metal stand, so arranged that the lens can be moved about a horizontal and also round a vertical axis, and lowered and raised at will. The filtered sun's rays are focussed upon the area of skin to be treated, and at this spot is placed the compression apparatus. This is a very flat cylinder made of two plates of rock crystal fixed in a metal ring. Through the compression apparatus passes a current of cold water, so that the instrument is used to render the part to be treated bloodless and also to cool it. The pressure apparatus is held on the skin by a nurse throughout the whole sitting, which lasts one hour or a little more. The spot treated at each sitting is about the size of a sixpence.

The electric light apparatus (Fig. 2) is much larger and more complicated. Attached to a strong metal ring round a large arc lamp, of 30,000 to 35,000 candle-power, are four long cylinders like telescopes. Each telescope consists of two parts. The upper part, closed at each end by rock crystal lenses, makes the divergent rays of the arc light parallel, and the lower piece brings the rays thus rendered parallel, to a focus on the skin of the patient. The lower part of the apparatus is filled with distilled water and is surrounded with a jacket through which cold water circulates. The compression apparatus used for the sun treatment is placed, as before, at the focus of the light to render the skin bloodless and to keep it cool. The length of the sitting is one hour. There is no blue solution in the electric light apparatus as now made, as it has been found in practice that the tube of distilled water and the circulating water in the pressure glass are sufficient to absorb the comparatively small amount of heat-rays given off by the arc light. Rock crystal lenses are used because ordinary crown glass prevents a great part of the chemical rays from passing through.

FIG. 1.—The treatment by sun-light

As a result of an hour's application of the light the skin may be a little red, but there is no proper reaction for from six to twelve hours, when there is definite redness and swelling and sometimes slight blistering. In from three to seven days all trace of reaction has usually disappeared, and the skin, though still hyperæmic, can be treated again if necessary. The process is repeated over the whole of the diseased area and especially at its margins, the most active parts, until every sign of lupus tissue has disappeared. If the disease is extensive, the treatment lasts many months. It must be noted that in many of the bad cases not only is the skin affected, but also the mucous membranes lining the mouth and nose, and these parts can very rarely be influenced by the light.

In Copenhagen there is a Light Institute under the direction of Prof. Finsen, and a very large number of patients, more than 500, have passed through the institution. It was in Copenhagen that the Queen saw the treatment, and Her Majesty was so impressed with the good results attained there that she graciously presented a set of the apparatus to the London Hospital a little more than a year ago. The demands upon that institution became so great that a second and a third lamp had to be put up, and even with these it is impossible to cope with the influx of patients from all parts of the British Isles, and even from such distant colonies as Newfoundland and New Zealand.

The drawbacks to the treatment are, first, the length of time which a severe case takes, and, secondly, the cost. Not only is there the cost of the electric light and the necessary maintenance, but every patient has to be attended by a nurse. At the London Hospital it has been found that it costs about 400*l*. or more a year to run one lamp, so that the light department there necessitates an expenditure of 1200*l*. a year. It is, therefore, gratifying to find that Mr. Alfred Harmsworth has come forward and endowed one lamp by a munificent gift of 10,000*l*.

It must be noted also that public spirit in Manchester and Liverpool will shortly provide for the installation of the light treatment in these cities.

The results in cases of ordinary lupus are excellent, provided that the patients can remain continuously under treatment for a sufficient length of time. The average of a large number of cases is three months. Certain other diseases, lupus erythematosus, rodent ulcer and alopecia areata, are influenced favourably by the light treatment. In the first mentioned disease the results are not nearly so striking as in the common form of lupus, but about one-third of the cases do well.

The light treatment has been too recently tried in London for any definite statement to be made as to the permanence of the results. In Copenhagen it has been in use for five years, and some of the earliest cases are quite free from recurrence to date.

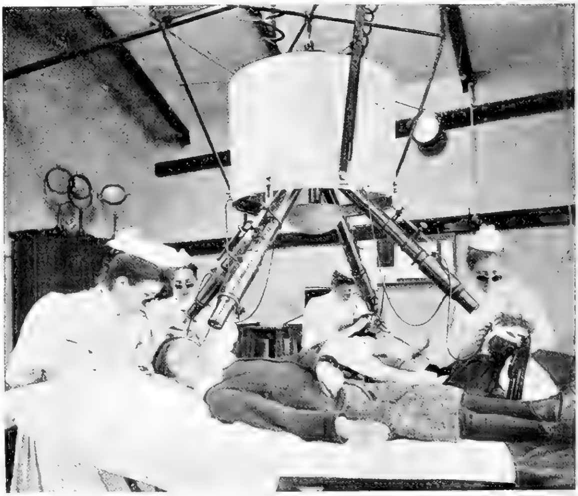


FIG. 2.—Treatment by electric light at the London Hospital.

The important advantages of this method of treatment over every other which has been used for lupus are that there is no destruction of tissue, there is no operation, and therefore no anæsthesia, for the treatment is pain-less, and, last but not least, in a disease which attacks the face the cosmetic results are wonderful. The skin of the areas treated is soft, supple and pale, and in some cases so nearly resembles the healthy skin that it requires careful observation to detect the difference. As we have already mentioned, the drawbacks are the time and the expense, and the impossibility of treating the mucous surfaces. If a cheaper method of application, with shorter exposures and the possibility of treating a larger area at one sitting, is introduced, there is no doubt that the light treatment will be used in every hospital where a suitable electrical installation is obtainable.

NOTES.

WE deeply regret to record that Prof. P. G. Tait, late professor of natural philosophy in Edinburgh University, died on Thursday last, July 4, at seventy years of age.

A STATUE of Chevreul is to be unveiled to-day at the Paris Museum of Natural History.

THE death is announced of Prof. T. H. Safford, professor of astronomy in Williams College, Williamstown, Mass., U.S.A. Prof. Safford was born in 1836 and was renowned for his mathematical attainments as well as for his work in preparing catalogues of stars.

THE death of Sir Cuthbert Peek, at the early age of forty-six, will be regretted in scientific circles, for he was a liberal patron of scientific work as well as an active worker. He was interested in many branches of science, being a Fellow of the Royal Astronomical, Geographical, Meteorological and other Societies, and of the Anthropological Institute. He also served on the councils of several scientific societies. He maintained a well-equipped observatory at Rousdon, near Lyme Regis, Devon, and the meteorological and astronomical observations made there have frequently been referred to in these columns. Science can ill afford to lose one who was in such complete sympathy with its interests.

TIDINGS have been received of the death of Dr. Joseph Le Conte, professor of geology and natural history in the University of California. He was born in Georgia on February 26, 1823, and was a son of Dr. Lewis Le Conte, the botanist. Having studied for the medical profession, and taken the degree of M D. at New York in 1845, he settled at Macon as a physician. Science, and particularly geology, however, attracted much of his attention. In 1856 he was appointed professor of chemistry and geology in South Carolina College, and he resigned this post in 1869 for the professorship at San Francisco. He was the author of a useful work on the "Elements of Geology" (1878), of which a revised edition was issued in 1889, and he gave special attention to the study of volcanic and also of glacial phenomena.

THE International Association for the Advancement of Science, Arts and Education will hold its second international meeting at Glasgow in the University and in the International Exhibition from July 29 to September 27.

THE *Times* correspondent at St. Petersburg states that the Imperial Geographical Society is sending an expedition to the Pamir under the leadership of Dr. Fedshenko with the object of making geological, botanical and zoological researches.

THE Institution of Mining and Metallurgy announce the intention to award two premiums of twenty-five guineas each for the best papers on the comparative merits of circular and rectangular shafts respectively, for mines of great depth. An annual prize of ten guineas will also be awarded for the best paper upon any subject connected with the treatment of ore. Particulars can be obtained from the secretary of the Institution, Broad-street House, London, E.C.

A CORRESPONDENT sends us the following translation of an article which appeared in the *Neue Freie Presse* of Vienna, and was translated in the Copenhagen Journal *Dannebrog* on June 28, upon the removal of Tycho Brahe's remains from his tomb. This is the first report we have seen of the event:—"On the occasion of the 300th anniversary of Tycho Brahe's death the Prague Town Council decided to gather together the remains of the celebrated astronomer, which were in the Teyn Church, and bury them anew. Under the guidance of Mr. Herlein this operation was commenced yesterday. After having lifted the stone block on the monument, which is situated near the first column in the nave and which bears a full-length effigy of the great astronomer, a semi-collapsed arch was found, and on removing the stones two mouldering coffins were seen. On the following day a committee met to determine whether these bodies were those of Tycho Brahe and his wife. Two workmen with candles descended into the vault and removed the débris which covered the coffins, the wood of which was quite rotten and fell to pieces at every rough touch. About 10 a.m. the lid of the first coffin was free to be removed. It was a surprising sight that met the eye; the body in the coffin was a wonderful likeness of the effigy on the monument. The head was slightly turned to one side, the bones of the face and the peaked Spanish beard being well preserved. The head was covered with a skull cap, and the neck was surrounded by a Spanish ruff which, like the remainder of the clothing, had suffered little during the 300 years since Tycho Brahe was laid in his last resting place. The feet were shod in long cavalry boots reaching up over the knee. That the body was Tycho Brahe's was also seen from the absence of the nose; Tycho lost this organ in a duel and wore a silver one in its place. Amongst the rubbish was found a silver wreath and spray of flowers. The construction of the grave was rather remarkable, the stones being laid loosely over one another. This is all the more astonishing seeing Tycho Brahe was buried with great pomp and honours, but it is supposed that the vault broke down during the restoration of the church in 1721."

DR. C. D. WALCOTT, director of the U.S. Geological Survey, contributes to *Science* of June 29 a long article on the relations of the national Government to higher education and research. The U.S. Congress has generously aided technical and higher education by grants of land to States and territories for educational purposes. This policy was inaugurated in 1787, when a contract was entered into between the Ohio Company and the Board of Treasury of the United States, whereby lot 16 in every township was given for the maintenance of public schools and not more than two complete townships were given perpetually for the purpose of a university, the land to be applied to the purpose by the legislature of the State. The most important act, after that of 1787, was that of 1862, granting land for the endowment of colleges for teaching agriculture and the mechanical arts. The total grants of land amount to about 20,000 square miles, about 4000 square miles of which are for the establishment of higher institutions of learning, and 16,000 square miles are in aid of "colleges for the benefit of agriculture and the mechanical arts." In addition, Congress now grants annually to each of the forty-five States the sum of 5000*l.*, which is expended under the direction of State boards. The policy of the U.S. Government has thus been to relegate the direct control of education to the States, aiding them in this work by grants of land, and in the case of technical education by grants of money also. The Government has carried on original research for its own purposes in the district of Columbia, through grants of money to its various scientific and technical bureaus. Of the total sum granted to these departments during the fiscal year 1901, more than 400,000*l.* or about 25 per cent. of the grant is available for scientific and research work and for higher education. The city of Washington possesses vast resources for work of this kind, and Congress has lately enacted that all the collections and museums in the city shall be available for higher education and research. The Washington Memorial Institution, which will begin work in three or four months, under the direction of Dr. Gilman, will suggest lines of investigation and coordinate the work that is being done by Government officials and private students.

As already announced, the British Congress on Tuberculosis will be opened at St. James's Hall on July 22. The Duke of Cambridge will inaugurate the congress on behalf of the King, who is patron. The work of the congress will be divided among four sections, viz.: (1) State and municipal—president, Sir Herbert Maxwell, F.R.S.; (2) medical, including climatology and sanitaria—president, Sir R. Douglas Powell; (3) pathology, including bacteriology—president, Prof. Sims Woodhead; (4) veterinary (tuberculosis in animals)—president, Sir George Brown. On Tuesday, July 23, the sections will begin their work, and at the second general meeting on the afternoon of this day Prof. R. Koch, of Berlin, will give an address. The chair will be taken by Lord Lister. On July 24, there will be, in the morning, a joint meeting of the medicine and pathology sections for a discussion on tuberculin. Prof. Brouardel, of Paris, will address the third general meeting in the afternoon. At this meeting Mr. Henry Chaplin, M.P., will be the chairman. The fourth general meeting, to be held on Thursday, July 25, will be addressed by Prof. McFadyean, of the Royal Veterinary College, and Lord Spencer will preside. The following are among the officers of the congress:—President of organising council, the Earl of Derby; chairman of organising council, Sir William Broadbent, F.R.S.; chairman of general purposes committee, Prof. Clifford Allbutt, F.R.S.; chairman of reception committee, Sir James Crichton-Browne, F.R.S.; hon. secretary-general, Mr. Malcolm Morris; hon. assistant secretary, Sir Arthur Trendell.

WE have received from the Deutsche Seewarte part x. of their colonial observations. This number contains a very valuable series of meteorological observations made in German East Africa, collected and discussed by Dr. Hans Maurer. Regular observations were begun there in 1891, but were not continuous owing to some unfortunate mishaps to the observers and to the difficulty of controlling the work at such a distance. Dr. Maurer was therefore dispatched by the German Government in 1895 to establish and superintend a network of stations, with the result that a very valuable series of hourly observations, from November 1895 to March 1899, have been obtained at several stations, and have been carefully collated and published in part i. of the work, including the harmonic constituents of the daily barometric oscillation for the monthly means. The second part of the present volume also contains some observations made before 1895 but not yet published, and a list of the works which contain observations previously published. The work is a most useful contribution to the climate of German East Africa.

IT has often been said that the study of electrochemistry is very much neglected in this country, and, indeed, until quite recently there was not, we think, to be found in any of our technical colleges a laboratory purposely designed for electrochemical and electrometallurgical work. Now, however, Owens College, Manchester, possesses in its new Physical Institute a laboratory thoroughly equipped for these purposes. Two rooms have been set apart for electrochemical work, the rooms chosen being in close proximity to the dynamo-room, from which currents up to 1000 amperes are obtainable. In addition to the ordinary equipment of a chemical laboratory leads have been run round the benches, so that every student has ready to his hand a supply of current at 2, 4, 6, 8 or 10 volts pressure. The apparatus requiring heavy currents, such as furnaces or large electrolytic tanks, is arranged on a bench at the end of the room at which the main leads from the dynamo-room enter. Bare copper wires are used for the conductors, the film of oxide and sulphide which forms on them protecting them sufficiently from too rapid corrosion. Now that Owens College has set so good an example, it is to be hoped that it will not be long before the other technical colleges recognise the need of efficient means of training students in this very important subject. Considering that a supply of cheap electric power is scarce, England may not be perhaps the most suitable country for electrochemical industries, but its backwardness in their development is undoubtedly aggravated by the lack of opportunity for young engineers to study the principles of electrochemistry and electrometallurgy.

NEWCASTLE-ON-TYNE may be congratulated on being the first place in the United Kingdom to see the inauguration of the practice of supplying electricity "in bulk." The large power station of the Newcastle-on-Tyne Electric Supply Co. was formally opened by Lord Kelvin on the 18th of last month, and the credit for the successful starting of the system must be shared jointly by this company and the Walker and Wallsend Union Gas Co. This latter company are taking a large supply from the Newcastle company and distributing it throughout the area under their control, which includes a number of big engineering and other works which require a supply of electricity for motive power or lighting. Many of these works make use of so much power that it has been found necessary to erect a separate substation in each case, power being supplied at high pressure to the substation and thence, after the pressure has been reduced, being distributed throughout the works. Supply is obtainable on either the continuous-current or three-phase systems. For the purpose of supplying the three-phase current, there are to be at the Neptune Bank station four 700 kw. sets generating at 5500 volts, and a 1500 kw. Parsons turbo-alternator. The continuous current is supplied by four 100 kw. dynamos generating at 240 volts; there is also a 150 kw. motor generator taking three-phase current at 5500 volts and generating continuous current at 240 volts, but designed so that it can be used in the opposite direction—that is to say, being driven by the continuous current and generating three-phase currents. A site has been obtained for the erection of another generating station in which to put up new machinery when the present station becomes fully loaded.

WE have received from the Meteorological Reporter to the Government of India a report on cloud observations and measurements in the plains of the North-Western Provinces of India during the period December 1898 to March 1900 (Indian Meteorological *Memoirs*, vol. xi. part iii.). The observations were taken and discussed under the superintendence of Mr. E. H. Hill; they include both the heights and movements, measured by means of two photogrammeters and a Fineman's nephoscope. In the fifteen months under review about 900 pairs of plates were exposed, and from these nearly 1000 calculations of heights of clouds have been made. The measurements have been arranged according to two seasons—June to October (the wet season, including the monsoon months) and November to May (the dry season). In the wet season the mean height of the cirrus was 35,000 feet, and the mean velocity 17·4 miles per hour; in the dry season 41,963 feet, and the mean velocity varied from 79 to 89 miles per hour. The mean height of the cumulus in the wet season was 5450 feet, and in the dry season (January and February only) 4100 feet, the velocities being respectively 13·7 and 10·2 miles per hour. The maximum velocity of the cirrus was estimated at 282 miles per hour both in February and March.

AN interesting letter by L. Schäfli on approximate integration is reproduced by Herr J. H. Graf in the *Berner Mittheilungen* for 1899, recently sent to us. The letter was written to a friend in explanation of certain difficulties he had experienced in reading Raabe's books on the calculus, and it probably dates from about 1840. It appears to throw some new light on the history of Bernouilli's numbers and functions, besides affording evidence of Schäfli's great power as a mathematician.

IN the *Journal de Physique* for May, M. Bernard Brunhes writes on the entropy of a gaseous mixture in combustion. It has been hitherto regarded as an objection to the use of entropy diagrams that they could not be used in connection with gas and oil engines, on account of the essentially irreversible nature of the explosions and the consequent uncertainty as to whether the entropy of the mixture was calculable or could even be said to exist. M. Brunhes now shows that, under certain well-defined conditions, the entropy is both determinate and calculable.

PROF. ORESTE MURANI points out in the Lombardy *Rendiconti* that a focus-tube at a certain degree of vacuum acts like an "electric valve" for alternating currents, in that it allows the current to pass in one direction but not in the other. The notion of an electric valve appears to have been originally due to Gaugain, and it has been known that a Geissler's tube in which the electrodes have different forms may act in this way. In the case of a focus-tube there appears to be a superior and an inferior limit to the degree of exhaustion at which it acts in this manner, the superior limit corresponding to a pressure of about 0·1 mm. of mercury, and the inferior limit, which has not been determined with such certainty, corresponding to 0·07 mm. Prof. Murani considers that a focus-tube may be used to indicate the sense of a discharge in certain cases where a more direct method is inapplicable; it might be also used to convert an alternating current into a direct one, but the intensity of the latter would be very small.

THE monaural localisation of sound receives treatment at the hands of Prof. James Rowland Angell and Dr. Warner Fite in the *Psychological Review* for May. The paper reports a series of observations on the capacities of auditory localisation in a person entirely deaf in one ear, but parallel observations have in certain cases been made upon a person of normal hearing. So far as it is possible to briefly give some idea of the conclusions, it is shown firstly that the differences in the localising capacity for complex sounds in binaural and monaural hearing are, so far as concerns these subjects, interpretable as chiefly differences in the magnitude of the difference limen for locality rather than as absolute differences in the kind of localising process involved. The experiments amply sustain the introspection of the subject in pointing to qualitative differences in the sounds coming from different directions as the basis of the localisations. Such qualitative differences may be due to the damping or reinforcing of certain partial tones by the organs of the ear and the head, and it is noteworthy that generally sure tones are unlocalisable in monaural hearing. The presence of eye-reflexes was often very marked, and the final localisation was frequently made on the basis of a seeming correspondence between the eye-strains and the supposed direction of the sound. This statement, however, leaves untouched the physiological basis of the eye-movements. Finally, there is no good evidence for supposing that cutaneous sensations play any part in the localisations.

THE thermal conductivity of the living human skin forms the subject of an investigation by Mr. J. Lefèvre in the *Journal de Physique* for June. Regarding the skin as a wall about 2 mm. thick, three coefficients have to be found, namely, the surface conductivity, the true conductivity through the substance forming the skin, and the internal surface conductivity between the skin and the adjoining tissues. To find these it was necessary to determine the rate of flow of heat across a unit area of the skin, and to measure the distribution of temperature from the surface downwards. For the former purpose M. Lefèvre immersed himself in a bath of water which served as a calorimeter, for the second he used thermoelectric elements, that used for subcutaneous observations taking the form of a fine needle. The experiments show that the skin is a bad conductor, its true conductivity being about the same as that of wood, of the same order as that of gutta percha, about 5 or 6 times that of wool and 750 times that of air. The conductivity is only half as great at 5° as at 30° C. The exterior surface-conductivity of the skin in contact with water appears to be approximately independent of the temperature, but the coefficient across the surface separating the skin from the adjoining tissues increases considerably as the temperature falls from 30° to 5°, and the latter increase more than counterbalances the decrease in the true conductivity, so that the loss of heat at 5° C. is twice or thrice as great as it would be according to Newton's law.

THE new number of the *Mittheilungen* of the Vienna Geographical Society contains two papers of interest. Herr H. Anschutz-Kaempfe describes a plan for exploring the Arctic Ocean and reaching the North Pole by means of a submarine vessel. Herr V. von Loziński treats of chemical denudation in relation to geological time, and gives a valuable summary of recent work bearing on this subject. The calculations of Mr. Mellard Reade and von Romer are specially dealt with, and the latter are repeated, with modifications, employing the most recent data of Murray, Gümbel and others.

DR. G. SCHOTT gives, in the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin*, an interesting forecast of some of the oceanographical results of the *Valdivia* Expedition, the full report on which may be expected next winter. The *Valdivia* observations have been combined with older material so as to bring maps of distribution of temperature, as far as possible, up to date, and from these Dr. Schott draws some important general conclusions. In the open ocean three temperature layers are recognised—a surface layer, 0 to 100 metres, in which the distribution is chiefly controlled by horizontal movements; a middle layer, 150 to 800 metres, controlled by vertical movements; and a bottom layer, beyond 1000 metres, in which horizontal movements are again specially important. A "Sprungschicht" occurs in every ocean, its mean depth being 25 to 80 metres in the Atlantic, 90 to 140 metres in the Indian, and 110 to 180 metres in the Pacific Ocean.

THE "Karlseisfeld" was first visited by Friedrich Simony in 1840, and since that date almost every change in the glacier has been carefully observed. Simony made his last photographic survey in 1890, and since his death a survey was made, in 1896, by von Groller. The retreat of the glacier during the five years following made another survey important, and this was accordingly carried out by Freiherr von Hübl. The results are published in the *Abhandlungen* of the Vienna Geographical Society, and, apart from their value as a study of the glacier, they form a model example of the application of modern methods of photographic surveying to work of the kind. The account of the survey forms the first of three parts of a report to be published under the editorship of Herr August von Böhm; the second part is to deal with the history of the glacier, and the third with its present development. In the same number of the

Abhandlungen Dr. Johan Cvijić publishes the second part of his morphological and glacial studies in Bosnia, Herzegovina and Montenegro, dealing with the *Karstpoljen* of Herzegovina and West Bosnia.

IN the *Transactions* of the Edinburgh Geological Society (vol. viii. part i. 1901) Dr. W. Mackie publishes some chemical analyses of Scottish sands and sandstones ranging in age from the Torridon Sandstone to the Blown Sands of Culbin. These analyses show that the proportions of the total alkalis follow fairly closely the results obtained from the proportions of fresh felspar in the several formations. Thus the Torridon Sandstone, an arkose, which contains fresh felspars, gave an average of 4·61 per cent. of alkali, chiefly potash. Soda is hardly represented. Hence the author doubts if such sandstone could be converted by metamorphism into a gneiss as has been suggested. The bearing of his analyses on similar questions is discussed, and he concludes (1) that a silica percentage over 78, an alumina percentage under 11, and a low percentage of lime and of total alkalis, especially of soda relatively to potash, indicate a sedimentary origin of metamorphic rocks; and (2) that a silica percentage not above 78, an alumina percentage not under 11, a high percentage of total alkalis, &c., indicate origin from an igneous rock. Mr. H. M. Cadell contributes to the same *Transactions* an important article on the geology of the Oil Shalefields of the Lothians; and Mr. Herbert Kynaston draws attention to the effects of contact metamorphism round the Cheviot granite.

THE second number of vol. ii. of the *West Indian Bulletin* has just been issued by the Imperial Agricultural Department. It is devoted wholly to a continuation of the full reports of the papers and discussions at the Agricultural Conference held at Barbados in January last. A great deal of the most useful information is brought together in these pages, the subjects dealt with being of a varied character, and not in all cases strictly agricultural. Dr. Alford Nicholls deals with the difficult question of bush fires, which he divides into five classes, approving of some, condemning others. Mr. Watts treats of soils in "orchard" cultivation, and of pine-apple cultivation in Antigua; Mr. Hart of rubber planting in the islands (illustrated); Mr. Sands of the cultivation of onions in Antigua; Mr. Meaden of breeding for beef in Trinidad, and, with Mr. Hart, of zebu cattle in the same island; and Mr. Whitfield Smith of artificial drying of cacao. Dr. Duerden's instructive communication on the marine resources of the British West Indies, which was some time ago issued as an extra number of the *Bulletin*, is reproduced *in extenso*.

THE afforestation of Ireland is advocated by Dr. R. T. Cooper in the *Irish Times* as a means of increasing the value and productiveness of the country. In Ireland there are about five million acres of unproductive land in a total acreage of 20,808,271, every square yard of which could be improved and fertilised by tree cultivation. Yet in all Ireland during the year ending June 1900 only 629 acres were planted with trees, while 1451 acres were cleared of timber. A serious attempt ought to be made to prevent this destruction of forest and recover the immense areas of "bog waste and mountain land" by a scientific distribution of trees.

AN interesting illustration of the practical importance of the recent discovery that leguminous plants possess the power of utilising the free nitrogen of the atmosphere, and thus increasing the nitrogenous constituents of the soil, is furnished by a pamphlet on shade in coffee culture, by Mr. O. F. Cook, being *Bulletin* No. 25 of the U.S. Department of Agriculture (Division of Botany). It seems that coffee growers in Central America, Venezuela and Columbia advocate a certain amount of shade for the coffee plantations, while those in Brazil and the East Indies do not. Mr. Cook suggests that the explanation of these contrary results lies in the fact that, while in the first-named countries the shade plants employed are almost exclusively leguminous trees and shrubs, in the latter they are chiefly figs, bananas and other non-leguminous plants. Hence the problem is one rather of nutrition than of insolation. A long list is given of the shade plants employed by coffee growers, and the pamphlet is illustrated by a number of photographs.

PROF. F. PLATEAU, of Ghent, has recently published several fresh papers, in the *Annales de la Société Entomologique de Belgique* and the *Mémoires de la Société Zoologique de France*, on the sources of attraction in flowers for insects. His previous conclusion, that insects are but little attracted by bright colours, was confirmed by experiments which showed that brightly coloured stuffs and scintillating metallic objects placed among the leaves had but little attractiveness for insects. With regard to the constancy of insects in visiting the same species of flower only on the same flight, he states that species of Bombus are very inconstant; *Apis mellifica* and *Anthidium manicatum* are, on the other hand, remarkably constant; species of Megachile and Coelioxys less so. The habit of constancy is attributed to a desire on the part of the insect for a saving of labour. The Syrphidæ (hover-flies) show a considerable tendency to be attracted by bright colours, whether of flowers or of inanimate objects. To this quality, and not to any æsthetic sense, is to be attributed their habit of hovering over flowers.

A WELL illustrated article by Prof. W. M. Wheeler, bearing the title of "Impostors among Animals," presents to the readers of the July number of *The Century Magazine* some of the leading facts connected with the "mimicry" of animate and inanimate objects by animals, and the consequent adaptation of the latter to their surroundings, in a pleasant and attractive manner. The first illustration shows the marvellous resemblance presented by certain bugs to the rugged bark of the stem on which they dwell, while the second displays the mimicry of orchids by various members of the Orthoptera, which assume a stationary posture with outspread wings on such occasions. Attention is specially drawn to the circumstance that while protectively coloured animals have, as a rule, a simple coloration and quiescent habits—frequently accompanied by the "death-feigning instinct"—those which depend for safety on "warning colours" present the very opposite conditions, being brilliantly and often gaudily coloured, while their habits are calculated to provoke attention and attract observation.

THE current number (vol. lxx. part iii., No. 1) of the *Journal* of the Asiatic Society of Bengal contains several interesting papers on folk customs in India. Captain W. Haig records the origin, the marriage laws, religious observances and funeral rites of the Rangari caste in Barar; in another paper he does the same for the Velama caste, and in a third communication he narrates the legendary account of Shah Abdur-r-Rahman-i-Ghazi, the warrior saint of Barar. Mr. S. Appadorai gives far too brief a paper on the heroic Godlings in Malabar folklore; and the riddles current in Bihar are recorded by Mr. S. C. Mitra. In a very interesting paper, illustrated by four plates, the Rev. P. O. Bodding describes a number of polished stone implements found in the Santal Parganas. These, as almost everywhere else, are believed to be thunderbolts. The Santals believe that a house where such a "thunderbolt" is kept is proof against lightning, and, as in the north of Ireland and elsewhere, they are also supposed to possess remarkable therapeutic power. Water in which a thunderbolt has been rubbed or placed is used, both externally and internally, to cure many ailments.

THE optical establishment of C. P. Goerz, at Friedenau, Berlin, has just produced its 100,000th lens—a Goerz double anastigmat. To have placed upon the photographic market 100,000 anastigmat lenses in eight years (since 1893) is a noteworthy record.

M. MORENA Y ANDA publishes in the *Transactions* of the "Antonio Alzate" Society of Mexico a table showing the diurnal variability of air temperature at Tacubaya for each month of the fifteen years 1884–1898. The hours of observation are 7 a.m., 2 p.m. and 9 p.m.

DR. MAX VERWORN'S "Allgemeine Physiologie" was welcomed as a valuable work when it appeared in 1894, and its scope and character were described in these columns (vol. li., p. 529). The work has been translated into English, French, Russian and Italian, and has taken its place as a standard textbook of general physiology. The third edition has now been published by Herr Gustav Fischer, of Jena.

THE syndics of the Cambridge University Press have undertaken the publication of a work on the fauna and geography of the Maldive and Laccadive Archipelagoes. An expedition, consisting of Mr. J. Stanley Gardiner, Mr. L. A. Borradaile and Mr. C. Forster Cooper, passed eleven months in these two groups, and the work will contain the scientific results of the visit. The chief object of the expedition was to investigate the interdependence of the physical and biological factors in the formation of atolls and reefs. To this end upwards of 300 dredgings were taken, a large number of soundings were run, and every group of organisms was carefully collected. The land fauna was carefully and exhaustively collected, and, being from an undoubted oceanic area, cannot fail to be of interest. The marine collections fill in an almost unknown gap between the Red Sea and the East Indies, and are the most extensive ever obtained from any coral, oceanic area. The work will be published in eight parts, of which the first will appear in October next.

IN the last *Berichte*, Nencki and Marchlewski describe the very interesting discovery of the close chemical relationship existing between the red colouring matter of the blood and the green chlorophyll of plants. Hæmatoporphyrin a derivative of hæmoglobin, and phyllocyanin obtained from chlorophyll, both yield on reduction hæmopyrrol, which is probably an isobutyl or methyl propyl pyrrol.

IN the newly issued *Bulletin International de l'Académie des Sciences de Cracovie*, L. Bruner publishes the results of his dynamic investigations on the bromination of aromatic compounds. The dependence of the velocity of bromination on the nature and position of the substituting groups in the benzene ring has been studied, and especially the catalytic activity of the most important bromine "carriers." In respect of this capacity, aluminium, chromium, iron and thallium salts, compounds of antimony and phosphorus, and finally iodine have been investigated. It is found that the catalytic activity of the bromine "carriers" depends upon the nature of the substance which is being brominated, so that the arrangement of these bodies in a general series according to their activity is not possible. For benzene and bromobenzene the order is (1) aluminium, (2) thallium, (3) iron salts, (4) iodine, (5) antimony, (6) phosphorus halogens.

THE additions to the Zoological Society's Gardens during the past week include two Green Monkeys (*Cercopithecus callitrichus*) from West Africa, presented respectively by Mr. R. de Courcy Hickton and Mr. S. Prust; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Mould; a Crab-eating Raccoon (*Procyon cancrivorus*) from South America, presented by Mr. B. W. Gardom; a Cuckoo (*Cuculus canorus*), British, presented by Lieut.-Colonel J. S. Benyon; an Alligator (*Alligator mississippiensis*) from North America, presented by Mr. W. Phillips; two Mocassin Snakes (*Tropidonotus fasciatus*) from North America, presented by Captain J. B. Gilliat; a Great Wallaroo (*Macropus robustus*), four Bridled Wallabies (*Onychogale frenata*) from Australia, two Parrot Finches (*Erythrura psittacea*) from New Caledonia, two Grey-headed Porphyrios (*Porphyrio poliocephalus*), two Ceylonese Terrapins (*Nicoria trijuga*) from India, five Derbian Sternotheres (*Sternothaerus derbianus*) from West Africa, two Grey Monitors (*Varanus griseus*) from North Africa, deposited; two Griffon Vultures (*Gyps fulvus*), European, received in exchange; a Wapiti Deer (*Cervus canadensis*), three Glossy Ibises (*Plegadis falcinellus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

LIGHT VARIATION OF THE MINOR PLANET (345) TERCIDINA.—In the *Astronomische Nachrichten* (Bd. 156, No. 3726), Herr J. Hartmann gives an account of his investigations of the variation in brightness of this small planet, first pointed out by Prof. Max Wolf, of Heidelberg, in 1899 (*Astronomische Nachrichten*, No. 3704). Two photographs were obtained on April 20 and a third on April 22, all with the large Potsdam refractor. Reproductions are given showing the trails of the planet with reference to the neighbouring stars. The period deduced is as follows:—

Beginning of increase ...	9h. 0m.		
Culmination	10h. 14m.	4h. 10m. = 250m.	
End of increase	13h. 10m.		

In the same journal Prof. Max Wolf gives a reproduction of a photograph taken with a 6-inch Voigtlander objective on April 22, the period determined from this being about 240m., which is in close agreement with that determined from the Potsdam photographs. The value determined from the older observations on 1899 November 4 was 290 minutes.

UNITED STATES NAVAL OBSERVATORY.—The recent issue of vol. i. of the second series of *Publications* of the U.S. Naval Observatory contains the first results of work done at the institution since the removal from the old site and the remounting of the instruments at the new observatory. In this volume a new method of publication is initiated, the observations made with one instrument and extending over several years being given together instead of all observations being published annually. This first volume contains the reduced observations of the sun, moon, planets and many miscellaneous stars made with the 9-inch and 6-inch transit circles during the years 1894–1899.

THE COMPTOMETER.[1]

IN acceding to the editor's request to contribute an article to NATURE upon this instrument, I should like at the outset to express the feeling of curiosity with which any one, familiar with the many arithmometers now so generally in use, must introduce himself to the examination of the comptometer. He will probably know before he begins that it is a mere adding machine; that whereas any arithmometer at each turn of the handle adds or subtracts, as the case may be, any figure set upon the machine, no matter how many digits within the capacity of the machine there may be, or how many times, or how fast within the capacity of the operator he may turn the handle, so that by means of the shifting result-slide multiplication and division can be performed at a rate, and without mental effort, that is a tax upon our imagination, the comptometer is a mere adding machine in which the operator acts upon one key at a time, which adds, each time he presses it, the number on its head to the corresponding digit on the register below. While, therefore, the machine is evidently well adapted for addition, which is so simple an operation that most people believe an instrument for the purpose is not worth the expense of purchasing, it would appear at first that the process of multiplying, to be explained shortly,

[1] Chicago, U.S.A.: Felt and Tarrant Manufacturing Co. Manchester: The Calculating Machine Co.

must be so cumbersome as to leave the comptometer far behind the more automatic arithmometers and so little better than head and pencil work as to be a gain of doubtful value.

When, further, he finds out that the inventor has evaded one of the principal difficulties of arithmometer design, which relates to the carrying of the tens, but which is due to the provision that this operation must occupy the second half of the turn of the handle and must, even then, be successive all down the row so as to allow of the nearly simultaneous and overlapping operations on all the digits, in the comptometer it is not possible where carryings come in to depress two keys simultaneously, for in that case the carrying will fail. On the other hand, if the keys are operated singly as many carryings as are necessary will be accomplished.

When, again, the arithmometrician, if I may so designate one familiar with the use of the arithmometer, finds that the comptometer, like the Income Tax man, can never subtract anything (it can only add, and so apparently can never divide) his despair is likely to be complete and he might well condemn the machine as a toy.

I will not go so far as to say that this exactly represented my feeling when I began to prepare this notice, for I had known the construction of the instrument for some years and was generally familiar with it. However, I did feel that, from a mechanician's point of view, it represented a retrograde step, and it was only the knowledge that the comptometer was extensively used in the United States, where appreciation of time-saving appliances is more developed than here, that made me feel that the comptometer must have advantages perhaps more than sufficient to compensate for its operative deficiencies.

The comptometer is a neat-looking instrument cased in mahogany, occupying $14\frac{1}{2} \times 7\frac{1}{2}$ inches on the table, and it is four inches deep. On the upper surface there are, in the eight-column machine, eight columns of spring-actuated number keys, nine keys to each column. The lowest key of each column, or rather the one nearest the operator, is marked in black 1, and these are called the 1 row, the next 2, and so on up to 9. All the even keys are flat and the uneven concave, so the operator knows at once, without looking, if his finger has got one row too high or too low. At the end next the operator is a row of nine number wheels, or one more than the number of columns, on one axle, seen through windows, so that only one figure on each can be read. This is called the register. The axle terminates outside on the right in a milled head, and below this there is a liberator handle. If the operator finds any figures on the result wheels that he does not want he presses the liberator handle with one finger and begins to turn the milled head. He then turns this as far as it will go, when nine 0's will appear on the number wheels. The machine is now ready to begin. If any key is pressed down the figure shown in black on that key will immediately appear on the corresponding number wheel below. If it or any other key in the same column is pressed, the figure on it will at once be added to the figure already on the number wheel. If the result is more than 9, 1 will be carried to the next number wheel to the left. If that should happen to be already 9, one will be carried on again and it will become 0. If all the figures are 9 and 1 is added to any one, then it and all to the left will immediately become 0. The action is almost instantaneous, but not quite, as each number wheel on becoming 9 leaves a trap set which it lets off on becoming 0. The trap then adds 1 to the next number wheel to the left. If this is 9 the same thing happens again, and so on across the machine as far as 9's happen to extend; so the action is really successive and the wave of motion can just be detected if it is looked for.

Any key instantly returns to its place under the action of a spring when the finger is removed. The necessary movement of the 1 keys is $\frac{1}{4}$ inch, while for the 9 keys $\frac{5}{8}$ inch is required with intermediate movement for intermediate figures. The pressure required is moderate, but more than is necessary for a typewriter. The rate of striking the keys may become, with practice, very great, so that, though numerous strokes are required in a multiplication, the result may nevertheless be found very quickly. Judging by the time that is stated to be necessary for working certain examples, a rate of six or seven strokes a second is certainly attainable, in fact, with but little practice I find this to be possible and that the machine works correctly at this rate.

The question will naturally arise here whether there is any fear of overshooting by the wheels of the register, as they are clearly set into very rapid rotation and have to be suddenly and exactly stopped. Various methods of stopping number wheels are in use in arithmometers—spring clicks, cams like the Geneva stop in clockwork, and a mere brake; the method used here is more direct and positive than any of these, for the key at the end of its depression operates a long light lever which brings a rigid stop between two pins on the number wheel of the register, locking it absolutely and ensuring its stopping in the correct position. The driving forward of the number wheels by the keys is effected by a series of long light levers, each operated by any one of the keys of one column. The 9 key is near the fulcrum end, while the 1 key is near the number wheel end and the others are in intermediate positions. A toothed arc at the end of each lever gears with a corresponding pinion on the common axis of the number wheels, and each of these pinions drives round its number wheel by a ratchet and pawl. Each number wheel in moving from 0 to 9 raises a light lever by means of a cam to its highest position, which it lets drop on completing its turn to 0 again. The lever in its descent moves on the next wheel to the left one tooth. If, therefore, the key of that wheel is being depressed at the same time, the carrying trap will not move it an extra tooth, but will merely join with its operating lever in moving it through one unit of movement, and the carrying will be lost.

To the left of each 1 key is a little push, which may be pressed with one finger when any key in that column is being depressed. This push throws the carrying trap out of gear with the next number wheel, so that no carrying can take place. This enables the operator to alter any figure in the result, or to bring it to 0 by adding to it the necessary number without, at the same time, changing any other figure to the left. They are also used in some special operations.

I have now probably written enough to enable any one interested in these machines to understand what the comptometer is like and also its mode of operation. The next thing is to explain how a machine that can only add, and only do that one figure at a time, may nevertheless be used for performing all the ordinary arithmetical operations, such as any arithmometer will perform.

Addition needs no more explanation. The speed merely depends on the rate at which an operator can read the columns of figures and get his fingers on to the right keys. A mere dab at the key such as is desirable with a typewriter is not appropriate here, as the key must be pressed right down to its stop, otherwise it may add a number less than that printed in black upon its head. To acquire the proper stroke, high speed and certainty of getting on to the right keys evidently requires practice; it would be interesting to see a really skilled operator at work.

In most arithmometers subtraction is effected (this is most generally wanted for the purpose of division) by turning the number wheels in the reverse direction, when the carrying acts in the reverse direction also. It is merely addition backwards. There is, however, a method of in effect subtracting on a machine which, like the comptometer, does not admit of backward motion. It is to add the arithmetical complement. This, for instance, has been used in some operations in Mr. Edmondson's circular machine. If you wish to subtract, say, 7, you have merely to add 3 and prevent the machine from carrying with the push. If you wish to subtract, say, 29, you have merely to add 71 and prevent the second figure from carrying. Similarly, to subtract, say, 23456789, it is merely necessary to add 76543211, each digit to be added being 9 – the one to be subtracted except the last operative digit, which must be 10 – the one to be subtracted, or 1 more than in the case of the others. If the arithmetrical complement had to be found by the operator the machine would not be of much use, but it has not. Every key has a smaller figure in red upon it, which is 9 – the black figure on the key. All that is necessary, therefore, in subtraction is to work with the red figures, bearing in mind only that the last operative figure to the right must be taken on the next key above, and that the push belonging to the last figure on the left must also be used to prevent carrying improperly.

Multiplication of any number by another of one digit is, of course, simple enough. To multiply, for instance, 37921 by 7 the series of keys corresponding to the number 37921 are each struck seven times, or else working on the 7 row the key farthest to the right is struck once, the next to the left twice, the next nine times, and so on. Either operation will produce the right answer, but the second one is preferable because, having put the finger on the last key of the seven row, there is no more occasion to look at the machine; the eyes can be kept on the paper and the series of keys struck the proper number of blows. There is no fear of sliding off on to the next row, as the change from the concave to the level keyheads would at once be felt.

If the multiplier has more than one digit the second method is still more to be followed. Take, for instance, an example illustrated in one of the pamphlets of the company, 2253×84. You do not, of course, strike the 2, 2, 5 and 3 keys 84 times or the 8 and the 4 keys 2253 times, though if you did the right answer would be found. You get on to the 4 row and strike the last key to the right three times, the next five times and the next two twice each. Then you get on to the 8 row and, starting at the last key but one to the right, you do the same again. The total number of strokes necessary may be found by adding together the digits in one factor and multiplying the sum by the number of digits in the other. In this case $12 \times 2 = 24$ strokes. That at, say, 6 strokes a second will be four seconds for the operation. Then the result has to be read and the result wiped off ready for the next. With a greater number of digits the operation is the same.

It constantly happens in extended calculations that the result upon the number wheels has to be further operated upon. If the next operation is one of addition or subtraction, the previous result is in the proper place; the same is true if it is to be divided. But if it has to be multiplied by a new number, the natural thing is to copy it down, wipe it off the machine and multiply in the usual way. This necessity, or supposed necessity, was overcome in Mr. Edmondson's machine by the ingenious method of "working off" results from the machine as distinguished from the usual way of working results on to the machine. That process is impossible in the comptometer, as it is in every other machine except Edmondson's, but instructions are given for a method of multiplying by a figure already on the register without the necessity of wiping it out, which is equally applicable to all arithmometers. It is simply to leave it there and multiply the other factor by a number which is one less than the right one. Then, as the new product by $n-1$ is added to that by one already there, the result is what is wanted. By beginning at the left hand side instead of the right, as explained in the directions, which are abundantly clear, each new figure to be used is read from the undisturbed number wheel most to the left, so that there is no necessity to write down the intermediate result. Also, in multiplying long decimals it is best to begin at the left, as in that case a sufficient number of figures can be found on the machine, those discarded having no meaning if the figures operated upon are the results of observations and are not absolute figures.

Division can, of course, be effected if subtraction can be, for it is merely necessary to go on subtracting the divisor from the earlier digits of the quotient until what is left in those places is less than the divisor, then to shift the place one to the right and start subtracting again. The number of times the subtraction is effected at each place is the figure of the quotient at that place. This, after all, is what every arithmometer does, and the series of indices which record the number of turns of the handle in each place enable the operator to read off the quotient when he has gone as far as may be necessary.

Now in the comptometer these counting wheels, or their equivalent, are absent, and so, unlike arithmometers, it does not leave a record of a multiplication actually effected, but only of the result. If, therefore, a wrong key has been struck, except that the result is wrong there is no means of finding it out, whereas in an arithmometer it is usual to compare the setting and the record of the counting wheels with the figures given, to be sure that the actual operation given to the machine was that intended. If any one or more of the counters indicates a wrong figure it is merely necessary to put that place into operation and make so many turns of the handle with the + or − gear, or forwards or backwards, as the case may be, to make the counter read the intended number, when the result will also become right.

In the comptometer these counters are absent, and there is no kind of record in a multiplication or addition except the result of what the operator really gave to the machine. It would therefore appear that in division there can be no record of what was done, and, therefore, that it would be necessary to write down figure at a time the number of times the set of keys were struck in each place. It is just here that a pleasant surprise is met with, and a property of the method of subtracting, by adding the arithmetical complement, is available which I do not think would be foreseen by the arithmometrician in general.

The property is this. If the arithmetical complement is added to the group of digits to the left of the dividend that would be first used in ordinary division, and if the push is not put into operation to prevent the carrying, then when the addition has been effected the right number of times the digit on the result wheels which has received these carryings will itself be the same as the number of additions, and the figures to the right of it will have become less than the divisor. All the operator has to do, therefore, is to watch this wheel and count 1, 2, 3, &c., every time he strikes the proper keys; when this wheel reads the same number as his count he then looks at the figures to the right; if they are more than the divisor he goes on striking and counting until they are less. The counting here is not necessary, but it is safe. As soon as they are less the wheel receiving the carryings records the corresponding figure of the quotient, the same number, in fact, that he will have counted.

This operation is best explained by the aid of an example. Divide 365 by 52. 365 is first set on the result wheels as far to the left as possible. Then the keys carrying the red numbers 5 and 1 in the columns over 6 and 5 are struck, while the operator watches the wheel at first showing 3 and counts 1 for each time he strikes the 5 and 1 keys. These really add 48 each time.

The series of numbers indicated below will then one by one appear:—

	365
Count 1	413
,, 2	461
,, 3	509
,, 4	557
,, 5	605
,, 6	653
,, 7	701

The operator watches the 3 gradually getting larger while he counts. When he has counted 6 it also will read 6, but the next two figures, 5 3, are more than the divisor, so he goes on. The next count, 7, then necessarily agrees with the indication of the wheel which receives the carryings, and the operative wheels to the right show 1 as the temporary remainder, so the answer at present is 7 and 1 over. If a long decimal answer is required the figures are made to slide along the keys on the rows on which they find themselves, in this case two places at first and then one place at a time, and are pressed down, the fingers alternately and simultaneously rising and falling, while the operator counts and watches the wheel receiving the carryings, and thus each new figure of the quotient is found, the time necessary for a figure varying from two to five seconds according as it is low or high. This is the time I require after no regular practice. I expect a skilled operator would require but little more than half as much. It seems strange at first that the mere process of addition should, where necessary, lead to a long decimal quotient, but, as explained above, such a result must follow.

The gradual and irregular change of the wheel receiving the carryings until it agrees with the count, so as to give a figure of the quotient, also seems mysterious. The manufacturers do not think it necessary to explain to users why this is so, but they give the following somewhat wholesome advice. "Do not worry about why the above process brings the answer. It is simply an arbitrary rule by which any and all examples in division can be computed on the comptometer, and, once understood, is so simple that it cannot be forgotten. All there is to it is that you strike the divisor on the keys just as many times as indicated by the figure in the 'next place to the left in the register,' and then, if the remainder is larger than the divisor, strike the keys again once or more times until the remainder becomes smaller than the divisor."

There is no occasion for much worry any way, for the mystery may be explained quite easily. Let $na+r$ be the dividend and a the divisor: then n is the quotient and r is "over." What is done by the machine is to add $1-a$ n times, counting up to n. When this has been done the result will be $na+r+n(1-a)$ $= n$, and r is "over."

The operation described is quite simple, easy and quick where the divisor has two figures only, and is not inconvenient with as many as four, for then two fingers of each hand may be used and the keys struck without looking at them. When the divisor has more than four figures the process is modified in an ingenious way, but in such cases the comptometer is, in my opinion, definitely less convenient than any good arithmometer.

The comptometer is conveniently available for ordinary commercial operations, such as interest and discount, as well as for merely adding up accounts. In the ordinary machine with only decimal notation the last two columns must be retained for the pence, the next two for the shillings, leaving all the rest for the pounds. However, a special build is now promised with special shilling and pence columns, so that on this any number of money entries, taken in any order, may be very quickly added up. Nevertheless, the process of dividing by 12 or 20 on the decimal machine, for which it is necessary to strike the keys marked in black 8 and 8 or 1, as the case may be, is so rapid that the pence when added up become shillings and pence on the register in a moment, and the shillings, which must be added after the pence, become pounds and shillings in even less time, and the pounds, shillings and pence so obtained are in their proper places. The comptometer arranged for British currency would, however, be the more convenient where the adding up of accounts is mostly wanted, but it does not seem as if it would meet every case that will arise. For instance, in a large retail business the number of entries to be checked of this type, $23\frac{3}{4}$ yards at 7*s.* $9\frac{1}{2}$*d.* a yard, is so great that in one case that I know of a special branch of the office is devoted to this work alone. The cost of this branch amounts to 1000*l.* a year, and yet, partly in consequence of the amazing quickness of the clerks, but chiefly because of our hopeless non-decimal system, it is not possible with much advantage to employ mechanical means of calculation to reduce this tax upon the business. Now with a decimal money system the multiplication by 23·75 in a machine would be direct and simple enough, but I do not see how this could be *directly* effected upon the British currency comptometer. I do not see how multiplication or division by numbers of several digits can be advantageously carried out.

As a last example of the way in which ingenuity has been exercised in finding a way of making this adding machine perform other operations, I may refer to the directions for finding a square root. It is not my intention to explain this process here, but simply refer to the artifice. "The simplest way to extract square root on the comptometer is to act on the principle that in the series of odd numbers, 1, 3, 5, 7, 9, &c., the square of the number of terms always equals the sum of all the terms." On this a process of addition is devised, using the red numbers on the keys, which I find, even without much practice, is surprisingly rapid for the first three figures, but which, like the ordinary head and pencil way, becomes increasingly cumbersome with a greater number.

The comptometer is like all arithmometers in that, having found one product of two or more numbers, or having any previous result on the register, any further products of two numbers may be added to or subtracted from this, one at a time, without the necessity of writing down any intermediate result or of separately finding these products; and then, when this is done, the sums or differences of all the products may be divided by a final number. If a further division is required the comptometer differs from all arithmometers except Edmondson's in that the result is found on the same register as the previous dividend, and so it might appear that any number of divisions could be effected. This is not the case, as the quotient occasionally moves up the machine towards the left and so gets out of range, whereas in Edmondson's, as the machine is arranged in a circle, the quotients and dividends may chase each other round the machine without ever coming to a dead stop. In ordinary arithmometers the quotient gets on to the counter wheels, when nothing more can be done to it unless it is again transferred to the register.

The operation, therefore, that these machines can perform with the greatest advantage is of the form

$$\frac{ab \pm cd \pm ef \pm \ldots}{r},$$

whereas the operation that is most favourable for the use of logarithms is of the form

$$\frac{a^n\, b^m\, tab^p\, \theta \ldots}{r^q\, s^t\, tab^v\, \phi \ldots},$$

tab representing any of the tabulated logarithmic functions. This advantage is so great that formulæ are artificially manipulated until they are finally rammed into this form and are then said to be adapted to logarithmic computation. Now the advantages of the calculating machines referred to are so great, and they are in so many ways preferable to logarithms where they can be used, that it is just as important to adapt formulæ to mechanical computation by putting them where convenient into the first of these two forms. Then, according as they can be put into one or other of these forms, machines or logarithms should be used for the purpose of computation, and no attempt should be made to use either for work specially adapted in this way for the other.

It may perhaps be worth while, by way of example, to mention that in the large number of corrections of the scale readings to bring them to circular measure that I had to make in my experiments on the constant of gravitation, I found I could calculate $\theta - \frac{1}{3}\theta^3 + \frac{1}{5}\theta^5$ in less time on an arithmometer than was required to look up the angle in the trigonometrical tables.

A few final observations are desirable bearing on the comparison of the comptometer with arithmometers.

In the first place the comptometer makes a most aggravating noise, like a typewriter through a megaphone; but other arithmometers are noisy, none, however, so bad as this machine. The only silent arithmometer is that beautiful machine invented by Prof. Selling, but this is practically unknown in this country.

To my mind the comptometer, with its single figure operations, is not so convenient as the arithmometer for reducing and computing observations in the laboratory. Its success is only rendered possible by the fact that it is a key machine, for key strokes may be so very rapid. The operating numbers on most arithmometers are set by slides and that is relatively slow, the operation, however, by the handle afterwards is vastly more rapid. Selling's arithmometer is, however, a key machine for the setting, while the turning handle is replaced by a sliding movement, one complete slide doing the work of five turns of the handle. Again, the fact that there is no record of the operating figures actually given to the comptometer seems to be, for scientific work, decidedly a drawback.

On the other hand the construction is admirable, perfectly adapted to its purpose, and, I should judge, fairly indestructible. I would on this point only make one complaint, which, however, refers to a defect in no respect essential to the machine. I refer to the difficulty of reading the numbers on the register. The figures are elegant, with a great contrast between the thick and the thin parts, and they are upon a polished reflecting wheel face. They are seen through small windows in a polished metal plate. The result is they are not as legible as they ought to be; great care has to be taken to get a suitable light, and it is useless to sit facing a window. The 3's may be confused with the 8's, the 1's with the 4's, and the 0's with the 9's. If block figures were used, and if, further, they were dead white upon a black ground, or even the reverse, and were not seen through a shining plate, this little defect, which I am surprised to see in the product of an American shop, would be remedied.

I have made no comparison between the comptometer and the slide rule because a good slide rule, such as Gravét's, cannot be approached in convenience by any mechanism where the limited accuracy of the slide rule is sufficient, nor can wheelwork machines directly find the fourth term in a proportion in which the three other terms are numbers, their squares, or roots, or trigonometrical functions, or the reciprocals of these, nor can they give logarithms at sight.

The attempts that have been made to increase the accuracy of the slide rule by increasing its length are not, in my opinion, of much success, because to gain only one more figure ten times the length, at least, is necessary. The rule must then be broken up gridiron fashion, as in General Hannyngton's,[1] Prof. Everett's and Thatcher's, or wound in a spiral as in Fuller's, or be altogether peculiar as Tower's. When an extra figure has been gained in this way the extreme handiness of the slide rule is gone, as it can no longer be carried in the pocket, it takes longer to find the place, and, as a rule, the range is limited to mere simple proportion. Where the accuracy of 1/10 per cent. given by a 26 cm. rule, or 1/20 per cent. by a half-metre Gravét rule is not sufficient, I should prefer in general five-figure logarithms or a wheel-machine to an extended slide rule. Whether the wheel-machine should be a comptometer or an arithmometer must depend upon the character of the calculations most often met with. I have attempted in my preceding remarks to give the information necessary to enable any one to judge in his own particular case.

C. V. BOYS.

[1] The Slide Rule Extended. E. and F. N. Spon, 16 Charing Cross, and Aston and Mander, Old Compton Street, Soho.

RECENT REPORTS OF THE SMITHSONIAN INSTITUTION.[1]

THE field of operations of the Smithsonian Institution is so extensive that it is impossible to survey adequately the work carried on in it. The liberality of the Institution has made many students of science acquainted with the researches and results of others, and has placed the whole world of scientific activity under an obligation. In addition, each of the departments under the direction of the Institution is a living centre of investigation, from which contributions to natural knowledge are continually emanating. These departments are the United States National Museum, the Bureau of American Ethnology, the International Exchanges, the National Zoological Park and the Astrophysical Observatory.

Following the precedent of several years, Prof. Langley gives, in the body of his report referred to in the footnote, a general account of the affairs of the Institution and its bureaus, while the appendix presents more detailed statements by the persons in direct charge of the different branches of the work. Independently of this the operations of the National Museum are fully treated in a separate volume of the Smithsonian Report, and the Report of the Bureau of American Ethnology constitutes a volume prepared under the supervision of the Director of that Bureau.

Parts of Prof. Langley's report are given below, together with references to some of the contents of the Smithsonian Report for 1899, and the Annual Report of the National Museum, recently received. Two recent reports of the Bureau of Ethnology will be noticed separately.

Astrophysical Researches.—Experiments in the solution of the problem of mechanical flight have been continued, and the Astrophysical Observatory has been active in the investigation of the solar spectrum. The first volume of Annals of the Observatory has been issued. It is devoted primarily, though not exclusively, to the investigation of the infra-red solar spectrum, its absorption lines and its variations in terrestrial absorption. This research, and the development of the sensitive bolographic apparatus with which it has been carried on, have largely occupied the Astrophysical Observatory since its foundation, and are a continuation of researches in which Prof. Langley was engaged for many years at the Allegheny Observatory.

As readers of NATURE are aware, successful observations were made of the solar eclipse of May 28, 1900. A considerable number of photographs of the corona were secured, some of which are upon an unprecedentedly large scale, and these, it is believed, will be of value in investigations of the nature of this still enigmatical solar appendage. A photographic search for hitherto unrecognised objects near the sun developed the fact that even in an ordinary sky, in an eclipse in which the reflected sunlight was brighter than usual, stars as small as the 8·3 magnitude could be secured.

The apparatus employed was designed, not so much for this, however, as for the obtaining evidence of possible intramercurial planets, but upon this latter point no final opinion can be given. Certain suspicious objects are found on the plates, but unfortunately observations of the same kind at other stations were unsuccessful, so that there is nothing with which to compare them. Studies are still going on, however, and it is possible that this part of the observations may yet yield results of interest.

The delicate and difficult observations upon the heat of the inner corona were made by means of the bolometer, and appear to have been quite successful, being perhaps the first trustworthy observations of the kind; they lend some additional weight to the view that the corona is something analogous to an electric phenomenon.

The Hodgkins Fund.—The different branches of research now progressing under grants from the Hodgkins fund are making satisfactory advances.

Prof. William Hallock, of Columbia University, New York, has supplemented his report of last year by a summary of the further progress of his investigation of the motion of an air particle under the influence of articulate speech. The instruments which Prof. Hallock has invented, and is now perfecting, have proved a great aid in this research, and will, he states, enable him to settle definitely the question of phase differences in the components of a complex sound.

Prof. A. G. Webster, of Clark University, reports the completion and successful application to the use for which it was designed of the new apparatus, perfected with aid from a Hodgkins grant, by means of which it is now possible to measure the intensity of rapidly varying sounds with an accuracy not hitherto attained. A grant has been made to Prof. Louis Bevier, of Rutgers College, for an investigation of vowel-timbre on the basis of the phonographic record.

The meteorological investigations with kites have been successfully continued at Blue Hill under the direction of Mr. Rotch with the assistance of a grant from the Hodgkins fund. In addition to these investigations, a Hodgkins grant has been made to enable Mr. Rotch to carry on a series of experiments in space telegraphy, it being thought that the unprecedented heights attained by kites might materially extend the range of communication by this method. In the preliminary experiments, however, kites were not used, sufficient elevation being attainable without them, but when the difference between the stations was increased from one mile to three, kites were employed to raise the transmitting and receiving wires. In the later experiments it was found, not unexpectedly, that the long wires, carried up and supported by kites, collected so much electricity as to interfere with and greatly complicate the messages sent from station to station. These interruptions seem to show that the limit of elevation for the receiving wire was under these conditions less than 500 feet. The greatest distance covered in the experiments was approximately twelve miles, from a wire supported by a kite about 200 feet above Blue Hill to the tower of Memorial Hall in Cambridge, which was used as the receiving station. These experiments draw attention to the fact that electrification increases with the altitude to which the wire is carried, and that it is always present, although varying with the meteorological condition of the atmosphere.

Dr. Carl Barus has been given a grant from the Hodgkins fund in aid of his experiments on atmospheric condensation. This research is supplemental to the experiments already conducted by Dr. Barus, as described in *Bulletin* No. 12, of the Department of Agriculture, and will be (1) a study of the origin, activity and growth of the condensation producing dust particles; their reactions on each other, their relation to electric radiation, &c.; (2) a study of the growth, &c., of water corpuscles after condensation; the reaction of corpuscles of different sizes on each other, &c.

A grant has been approved on behalf of Prof. Dr. R. von Lendenfeld, of the University of Prague, for a study of the motion of birds in actual free flight, a subject to which, although primarily known as a zoologist and meteorologist, Dr. von Lendenfeld's attention has been directed for years, and for the better understanding of which he has made numerous anatomical preparations, physiological observations, &c. The investigations of Dr. von Lendenfeld have been aided by the Society for the Advancement of Scientific Research in Bohemia, and also by the Austrian Government.

A grant from the Hodgkins fund has been made to Dr. V. Schumann, of Leipzig, for the prosecution of researches in connection with the spectral relations of atmospheric air. The apparatus by means of which Dr. Schumann has heretofore secured such noteworthy results being chiefly of his own invention, he has been permitted to apply the present grant to the further perfection of his instruments before entering upon his special experiments, which will be definitely reported upon as they progress.

Standards of Colour.—Mr. Robert Ridgway, curator of ornithology in the National Museum, published a number of years ago, for the use of naturalists, a handbook on colour, and he requested a grant from the Institution for a new edition. It appeared to Prof. Langley that a work upon a more extended scale and a somewhat different plan would be of value primarily to naturalists, but also in every department of science, to artists, and in many branches of industry.

At the present time there is practically no uniformity in the common use of colour names, one name designating, as a rule, as many as half a dozen different shades; nor is there any absolute method commonly available by which a person in one place can

[1] Report of Prof. S. P. Langley, secretary of the Smithsonian Institution, for the year ending June 30, 1900. Pp. iv + 117.
Annual Report of the Board of Regents of the Smithsonian Institution for the year ending June 30, 1899. Pp. lxiii + 672.
Report of the U.S. National Museum for the year ending June 30, 1899. Pp. xv + 598. (Washington: Government Printing Office, 1901.)

describe to a person in another the exact shade or tint meant by a given name. The production of a work which would obviate these difficulties and make available what might be called the "constants of nature" in colour, is directly in line with previous publications of the Institution in endeavouring to establish standards whereby a definite nomenclature in scientific and popular writing might be introduced.

Prof. Langley, after consulting with others expert in the matter, decided that it would be desirable, not only to secure more permanent tints, but to connect every tint published in the book with some definite wave-length in the spectrum, whether the solar spectrum or a composite one. The investigations of Prof. Rood and others show that it is difficult to do this directly, but that it can be effected by the use of intermediate means of comparison.

Again, experiments must be made to determine how far this large object (of connecting every tint employed with some definite wave-length or combination of wave-lengths of light) is practicable. If it be fully so, the work may be said to be in one sense something absolutely permanent, relating as it will to standards which can never alter with time, so that, as has been said, those who expect that their writings will be more permanent than the planet itself should take this method of illustrating them. The work promised such magnitude that a committee was appointed, and is now considering the subject.

Collected Papers.—The General Appendix to the Annual Report of the Smithsonian Institution may be termed a "source-book" of scientific history. In consists of reprints and translations of authoritative but popular scientific articles which appeared during the year of the Report. Some are addresses delivered in institutions concerned with the diffusion of knowledge, and others are papers contributed to scientific and other periodicals, and collectively they form an epitome of advance and opinion in all departments of science. There are in the volume before us (1899) no less than thirty papers of this kind, among them being translations of the following: influence of the wave-theory of light on modern physics, by Prof. Cornu; on the sense of smell in birds, by M. X. Raspail; have fishes memory? by Herr L. Edinger; the garden and its development, by Dr. P. Falkenberg; sea-charts formerly used in the Marshall Islands, with notices on the navigation of these islanders in general, by Captain Winkler; the peopling of the Philippines, by Dr. R. Virchow; list of the native tribes of the Philippines and of the languages spoken by them, by Prof. F. Blumentritt; and the sculptures of Santa Lucia Cozumahualpa, Guatemala, in the Hamburg Ethnological Museum, by Herr Herman Strebel.

National Museum.—Details in regard to the work of the U. S. National Museum are given in an appendix to Prof. Langley's report. To the geological collections were added some interesting fossil animals secured from the fields of Wyoming, and a large amount of zoological material was collected in Cuba and Porto Rico. There has also been transferred to the Museum the extensive and very valuable series of vertebrate fossils collected by the late Prof. Marsh during his connection with the United States Geological Survey. This collection aggregated five car-loads, and is particularly rich in specimens of the gigantic Dinosaurs, besides fifty skulls of Titanotherium, probably the best specimens in existence.

The Annual Report of the Museum for 1899 is largely devoted to a description of the collection of non-metallic minerals in the department of applied geology, by Mr. G. P. Merrill. The term non-metallic is used to designate minerals which, as exhibited in the Museum, are utilised in other than metallic forms. The subjects of remaining papers in the Report are:—A Primitive frame for weaving narrow fabrics, and pointed bark canoes of the Kutenai and Amur, by Dr. O. T. Mason; an early West Virginia pottery, by Mr. W. Hough; and a descriptive catalogue of a collection of objects of Jewish ceremonial in U. S. National Museum, by Drs. C. Adler and I. M. Casanowicz.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. G. S. TURPIN, headmaster of the Swansea Intermediate and Technical School, has been appointed to succeed Dr. Gow as headmaster of the Nottingham High School. Particulars as to the vacancy thus caused at Swansea will be found in our advertisement columns.

THE council of University College, London, have appointed Mr. J. D. Cormack, of the University of Glasgow, to the chair of mechanical engineering in this College, vacant by the resignation of Prof. Hudson Beare on his appointment as regius professor at Edinburgh.

The Education Bill (No. 2), was read a second time in the House of Commons on Tuesday, after a long and animated debate. As a consequence of the Cockerton judgment, the question had to be determined whether School Boards were the proper authorities to deal with secondary education or not; and the Government decided against them. The Bill is the first step towards the establishment of single local authorities connected with County Councils for the control of the whole of the work of secondary education in their districts.

THE Liverpool City Council unanimously adopted the following resolution at a meeting held on July 3:—"That the Council has observed with much satisfaction the growth and progress of the University College, and in view of the fact that the college authorities are taking steps to procure the establishment of a separate University for Liverpool records its opinion that it is desirable in the interests of higher education in the city that such a University should be established." It is understood that, though there has not yet been any appeal to the public, about 100,000*l.* has already been promised for Liverpool University, which will bring up the capital value of University College to about 600,000*l.*, and the promoters are sanguine that there will be little difficulty in raising this to 750,000*l.* The council of University College have elected Dr. E. W. Marchant to the lectureship in electrotechnics vacated by Mr. Alfred Hay's appointment to a professorship at Coopers Hill.

THE University of Birmingham is fortunate in having a strong man like Mr. Chamberlain to plead its cause and advance its interests. At the first congregation of the University, held on Saturday last, he again directed attention to the national importance of higher education and research, and referred to the liberal provision made for work of this kind in other countries. "I am convinced," he said, "that unless we overcome the innate conservatism of our people in regard to the application of the highest science to the commonest industries and manufactures in our land, we shall certainly fall very far behind in the race." Though the fact involved in this statement has been persistently brought forward in NATURE for many years, it cannot be too frequently reiterated in public to rouse wealthy citizens to a sense of their responsibilities as regards provision for national progress, and create a higher regard for scientific work than is at present possessed by Englishmen in general. It is not necessary to enlarge here upon the facilities for scientific work abroad, for scarcely a week passes without our having to record munificent donations by States and individuals for the erection of buildings in which such work can be carried on under favourable conditions. Mr. Chamberlain mentioned in his address that the Charlottenburg Technical High School cost half a million of money, and this is but one instance of many. A modern University ought at least to secure an equal sum of money to build and equip its scientific side, especially when the ideals are those sketched by Mr. Chamberlain in the following words:—"I venture to lay down four qualifications as necessary to a perfect University. In the first place, it should be an institution where all existing knowledge is taught. Such a University may, perhaps, never yet have been attained; want of means may always prevent it, but at least that was the object at which we should aim, and we should never rest satisfied until we can say that no student desirous of instruction in any branch of learning shall be turned hungry away from the doors of this University. No doubt the enormous development of knowledge, and especially of its scientific side, during the present century requires a certain specialisation in the teaching of that knowledge, and I think it may be desirable, I think it may be necessary, that Universities also should be specialised, and that one University should pay more attention than another to particular studies; but I believe at the same time that it would be fatal if in our desire as a modern University to give a special development to the practical and thorough teaching of our scientific work, it would be a great mistake, I say, if we were to exclude or to neglect the older branches of learning. Well, then, in the second place a University is a place where the knowledge that has been acquired has to be tested. And as to that I will only say that in the multiplication of examining bodies I hope that nothing will be done, either by us or by our successors, to lower the standards of proficiency, whether in the ordinary pass or in the highest honours. Then the third feature to which I should call attention, and which I am inclined to say is the most important of all, is that a University should be a place where knowledge is increased and where the limits of learning are extended. Original research, the addition of something to the total sum of human knowledge, must always be an essential part of our proposals. We want to secure that those who teach in this University shall never cease to learn, and that those who are students shall unite with them in the work of fresh and new investigation. And, lastly, a University is a place where the application of knowledge must be indicated and directed. That perhaps brings us nearer to what may yet be the distinctive feature of our University. At all events we start with the belief that here we are going to combine theory with practice, and to see that in our University we shall combine both in one course of instruction, with due regard to the needs of our own time and of our own district. And now, if I may summarise in one sentence what I have been saying, it is that a University should be a place where knowledge is taught, tested, increased and applied."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Meteorological Society, June 19.—Mr. W. H. Dines, president, in the chair.—A paper by Mr. H. Helm Clayton, of the Blue Hill Observatory, U.S.A., on the eclipse cyclone, the diurnal cyclones and the cyclones and anti-cyclones of temperate latitudes, was read by the secretary. The author has discussed the meteorological observations made along the path of the total solar eclipse in the United States on May 28, 1900, and also those made during three previous eclipses. He finds that a cyclone follows in the wake of the eclipse—though the changes are very minute and feeble—the fall of temperature developing a cold-air cyclone in an astonishingly short time, with all the peculiar circulation of winds and distribution of pressure which constitute such a cyclone.—A paper, by Mr. F. Napier Denison, of Victoria, British Columbia, on the seismograph as a sensitive barometer, was also read by the secretary. A Milne seismograph was installed in 1898 at the Meteorological Office, Victoria, B.C., and the author has since that time compared its movements with the changes of atmospheric pressure recorded by his "aërograph." He finds that when the barometric pressure is high over the Pacific slope from British Columbia southward to California, while off the Pacific coast the barometer is comparatively low, the horizontal pendulum of the seismograph tends to move towards the eastward. This movement appears to be due to a distortion of the earth's surface, caused by the heavier air over the Pacific slope depressing the underlying land surface below its normal position, while, on the other hand, the comparatively light air over the adjacent ocean tends to allow the sea and earth beneath to rise above its normal level. It has been found that when an extensive storm area is approaching from the westward, and often eighteen to twenty-four hours before the local barometer begins to fall, the pendulum of the seismograph swings steadily to the eastward, completely masking any diurnal fluctuations that might have existed, as the storm area approaches, and in the event of it being followed by an important high area, the pendulum will begin to swing towards the westward before it is possible to ascertain this area's position on the current weather charts.

Anthropological Institute, June 19.—Extraordinary joint meeting with the Folklore Society. Prof. A. C. Haddon, F.R.S., in the chair.—Prof. Haddon vacated the chair in favour of Mr. E. W. Brabrook, president of the Folklore Society.—Mr. E. S. Hartland exhibited the collection of Musquakie beadwork and other objects presented by the late Miss Florence Grove to the Folklore Society, and to be deposited in the Museum of Ethnology at Cambridge.—Mr. R. Shelford exhibited two charms against stomach-ache from Borneo.—Mr. H. Balfour read a paper, by Mr. W. G. Aston, C.M.G., on Japanese Gohei and Ainu Tirao.—Mr. N. W. Thomas read a paper, by Mr. E. Tregear, on the spirit of vegetation.

DUBLIN.

Royal Dublin Society, May 22.—Sir Howard Grubb, F.R.S., in the chair.—Prof. Hartley, F.R.S., and Mr. Hugh Ramage communicated a paper upon the banded flame-spectra of metals. This was a continuation of some former work on flame spectra at high temperatures by Prof. Hartley, published in the *Phil. Trans.*, in which it was shown that fluted and banded spectra are characteristic of many metals. The list is now extended, banded and fluted spectra of copper, gold, palladium, zinc, cadmium, aluminium, beryllium, lanthanium, indium and thallium have been photographed and the principal bands in their spectra measured. A banded spectrum has also been obtained from iridium. In well-defined groups, such as magnesium, zinc, cadmium, aluminium, indium and thallium, the spectra appear to be homologous.—Prof. Hartley communicated a paper on a theory of the molecular constitution of supersaturated solutions. The chemical constitution of these solutions, which exhibit the well-known phenomenon of sudden crystallisation when either a crystal of the same salt or one of the same constitution and isomorphous with it gains access to the liquid, has been thus explained by the author. When a supersaturated solution is formed the salt in solution is a definite hydrate, but it is not the same hydrated salt as that which crystallises out. The cause of the supersaturation is the greater solubility of the one hydrate over the other at a given temperature; and its conversion into the other by combination with some of the water, acting as a solvent, causes its sudden solidification. In cases where the supersaturated solution is prepared by digesting a dehydrated salt in cold water, the course of change is first hydration, secondly solution, and thirdly crystallisation. Reference is made to the work of H. Le Chatelier, Wyrouboff, and others.—Sir Howard Grubb communicated a note on a case of true stereoscopic effect obtained from a single picture, which he demonstrated by means of a model.—Mr. F. W. Moore exhibited and described a living specimen from the Botanic Garden, Glasnevin, Dublin, showing the germination of the double cocoa-nut (*Lodoicea sechellarum*).

EDINBURGH.

Royal Society, June 17.—Prof. Sir William Turner, K.C.B., in the chair.—Prof. Cossar Ewart, in a paper on in-breeding, gave the results of a number of experiments he had tried on pigeons, rabbits, mares and goats, and examined in the light of these the views as to the injurious effects of in-breeding which were held by certain naturalists. Thus Darwin had concluded that in-breeding was injurious; other biologists, including Weissmann, that it was not. Similarly, Huth and Westermark differed as to the harmfulness of consanguineous marriages. The general result of his own experiments led Prof. Ewart to the conclusion that in-breeding led to loss of constitutional vigour and sometimes of size, but not to loss of fertility; and the diversity of view held by naturalists he regarded as being due to the fact that members of one family often differed in constitution to a marked degree, brothers and sisters, for example, differing more than their parents, and there being occasionally greater similarity between second cousins than between first cousins. It was also pointed out that, in certain circumstances, in-breeding by arresting reversion (which was favoured by crossing) tended to favour the appearance of new varieties.—Mr. F. H. A. Marshall read a paper on hair in the Equidæ. It was found that the hairs of the three principal types of zebra were fairly distinct, while the Somali zebra stood quite by itself, a conclusion agreeing with that of Nathusias. The hairs of horses showed considerable variability dependent largely on the breed, while those of zebra-horse hybrids, so far as the observations went, were fairly constant in character. The hairs of the mane, as well as those from the sides of the body, were also dealt with. The paper concluded with a reference to a suggestion by Nathusias that, if the telegony hypothesis were true, we might expect to find evidence of it in the hair characters of the "subsequent foals." Such evidence was, however, utterly lacking.

PARIS.

Academy of Sciences, July 1.—M. Fouqué in the chair.—Chemical equilibria; phosphoric acid and the chlorides of the alkaline earths, by M. Berthelot. The author's recent experiments on the subject are continued, the reactions dealt with in this paper being those occurring between phosphoric acid, monosodium phosphate or disodium phosphate, and calcium, barium or magnesium chloride. It is found that the number of equivalents of the alkaline earth entering into combination with a molecule of precipitated phosphoric acid varies from 2 to 4, according to the nature of the substances and the time which has elapsed since the commencement of the reaction.—New treatment of niobite; preparation and properties of fused niobium, by M. Henri Moissan. The native mineral, consisting chiefly of niobic and tantalic acids together with iron, manganese and silica, is heated with charcoal in the electric furnace, a fused mass of niobium and tantalum combined with carbon being thus obtained. The two metals are separated by Marignac's method, based on the different solubilities of sodium fluoniobate and fluotantalate, the former salt being finally calcined and fused with charcoal. Niobium is thus obtained as a very hard, metallic mass, having a melting point above 1800°; it is almost unacted on by acids, and does not decompose water vapour at a red heat. When heated in oxygen, it burns with the production of niobic acid.—New nebulæ discovered at the Paris Observatory, by M. G. Bigourdan.—Observations at sea of the comet of May 1901, by MM. Doué and Rivet. The observations were made in the course of a voyage from Tahiti to Panama.—On a mechanical interpretation of the principles of thermodynamics, by M. André Séligmann-Lui.—On the indices of refraction of mixtures of liquids, by MM. J. de Kowalski and Jean de Modzelewski.—The dielectric constant of a mixture of liquids has been shown not to be connected by any simple law with that of its constituents, and it seemed of interest to determine whether this anomaly held with regard to the index of refraction, which is closely connected with the dielectric constant. Experiments with mixtures of alcohol and benzene, alcohol and toluol, and ether and chloroform have shown, however, that such is not the case, the index of refraction of each of the pairs of mixed liquids being readily calculated from the indices of its constituents.—Hertzian waves in storms, by M. F. Larroque. A demonstration of the production of Hertzian waves in storms and their transmission to great distances.—Acidimetry of arsenic acid, by MM. A. Astruc and J. Tarbouriech. If methyl orange is employed as indicator, one molecule of arsenic acid is neutralised by one molecule of potash, soda or ammonia and by half a molecule of baryta, strontia or lime, identical results being obtained in the cold and on heating. With phenolphthalein, however, two molecules of an alkali or one molecule of an alkaline earth are required; on boiling, no difference is observed in the case of the former, but one and a half molecules of baryta, strontia or lime are then required for neutralisation.—On the uncoloured compound of sodium tetrazotolylsulphite with ethyl-β-naphthylamine and its conversion into a colouring matter, by MM. A. Seyewetz and Blanc. The coloured substance, a red insoluble powder, is formed by the exposure to light of the uncoloured compound, and is identical with the product of the action of ethylnaphthylamine hydrochloride on tetrazotolidine chloride.—On the action of benzaldehyde on sodium menthol and new methods for the preparation of benzylidenementhone, by M. C. Martine. Sodium menthol resembles sodium borneol in its action on benzaldehyde, the product of the reaction being benzylidenementhone; this compound is also formed by the action of benzaldehyde on the sodium derivative of menthone.—Combinations of camphor with β-hydroxy-α-naphthaldehyde, by M. André Helbronner. The new compound, $C_{23}H_{26}O_2$, which is designated ethoxynaphthalcamphor, crystallises in brilliant white crystals melting at 100°; it is dextrorotatory. On reduction with sodium amalgam it yields a compound melting at 112°, which bears the same relation to the parent compound as benzylcamphor to benzalcamphor. Metoxynaphthalcamphor, which has also been prepared, melts at 78° and its reduction product at 96°.—Action of bromacetophenone on sodium acetylacetone, by M. F. March. The reaction studied gives rise to a triketone of the constitution $(CH_3 - CO)_2 = CH - CH_2 - CO - C_6H_5$, which forms large, colourless crystals melting at 57–58°; on treatment with soda it yields acetophenonacetone.—Action of hydrogen sulphide on acetylacetone, by M. F. Leteur. When hydrogen sulphide is passed into a solution of acetylacetone in concentrated hydrochloric acid, an abundant deposit of needle-shaped crystals is produced. This compound melts at about 163°, and is shown by analysis and by cryoscopic molecular weight determinations to have the formula $(C_5H_8S_2)_2$.—Influence of sodium fluoride in the saccharification, by seminase, of the carbohydrates contained in the seeds of leguminous plants, by M. H. Hérissey. Sodium fluoride, which was used as an antiseptic in the study of the saccharification, was found to exert a marked favourable influence on the process.—On epithelial centrosomes, by M. P. Vignon.—Observations on the root of vascular cryptogams, by M. G. Chauveaud.—On the vegetation of punctiform nostoc in the presence of different carbohydrates, by M. R. Bouilhac. Sucrose, maltose or starch may replace dextrose in the cultivation of nostoc, whilst with lactose or lævulose only a very feeble vegetation is obtained.—Generality of the fixation of metals by the cell-wall, by M. H. Devaux. The fixation of metals by the cell-wall in plants, previously demonstrated in the case of injurious metals such as copper, silver and lead, is now shown to be a very general phenomenon. The proportion of metal absorbed is always small, and is not sensibly increased by the use of more concentrated solutions.—On the optical data relative to the macle of pericline, by MM. F. Pearce and L. Duparc.—On the presence of Devonian strata containing *Calceola sandalina* in the Western Sahara, by M. G. B. M. Flamand.—Action of currents of high frequency on the urinary secretion. Information furnished by chemical analysis, by MM. Denoyés, Martre and Rouvière. During electrical treatment there is an increase in the amount of urine, and in the urea, uric acid, total nitrogen and salts contained therein.—Passage of carbon monoxide from the mother to the fœtus, by M. Maurice Nicloux.—Cellular heredity, by MM. A. Charrin and Gabriel Delamere.—On a reaction characteristic of pure waters, by M. H. Causse. Pure, uncontaminated water restores the colour of crystal violet which has been previously decolourised by sulphurous acid, but has no action on decolourised magenta or on paradiazobenzene sulphonate. In the presence, however, of human or animal excreta the colour of the two last mentioned reagents is restored, whilst the decolourised crystal violet is unacted on.

NEW SOUTH WALES.

Linnean Society, May 29.—Mr. J. H. Maiden, president, in the chair.—Notes on the botany of the interior of the Colony, part iii., by Mr. R. H. Cambage. Part iii. is descriptive of the botany of the country extending from the Bogan to the Lachlan, *viâ* Nymagee.—Revision of the Genus Paropsis, part vi., by Rev. T. Blackburn.—The nature of the bacteroids of the leguminous nodule and the culture of *Rhizobium leguminosarum*, by R. Greig Smith. The bacteroids of the leguminous nodule are neither higher nor lower types of growth, but are normal bacteria contained in a bulky branching capsule. A medium prepared from leguminous plants is not essential for the growth of *Rhizobium* as claimed by Hiltner. The author has grown the organism for more than a year on media devoid of all plant infusion.—On one of the so-called honeysuckles of Lord Howe Island, by J. H. Maiden. In the Society's *Proceedings* for 1898 (p. 126), the author described a tree under the name *Cupania Howeana*. He believes that this is identical with the plant described by Radlkofer in 1886 as *Guioa coriacea*, and gives the complicated synonymy of the species. The author tabulates the radical alterations that Radlkofer proposes in the nomenclature of Australasian Sapindaceæ and submits them for further consideration of Australian botanists since they were not adopted by Mueller.

CONTENTS.

THURSDAY, JULY 18, 1901.

MODERN ELECTRODYNAMICS.

Électricité et Optique: la Lumière et ses Théories Électrodynamiques; leçons professées à la Sorbonne en 1888, 1890 *et* 1899. Par H. Poincaré. Deuxième édition, revue et complétée par J. Blondin et E. Néculcéa. Pp. x+642. (Paris: G. Carré et C. Naud, 1901.) Price Fr. 22.

IN the present state of electrical and general physical theory there are probably few undertakings more useful towards progress than a critical discussion of the views of other writers by one who has himself thought deeply and read widely on the subject.

We may recall the stimulus afforded to the progress of Maxwell's electric theory on the Continent by Helmholtz's early series of critical memoirs (now largely out of date, having served their purpose) that were devoted to the examination of the relation in which that theory stood to the views of electrical action then current.

The lectures of M. Poincaré, reported and published by his pupils about ten years ago, possessed great interest as being an account of the then fresh advances constituted by the experimental investigations of Hertz, from the hand of a writer who occupied one of the highest positions both in the domain of pure mathematics and in that of its physical applications. The writer's unlimited command of analysis and the range of his interests were certain to shed new lights on the subject-matter of which he undertook the exposition. A second edition of the "Électricité et Optique" is now published in a volume of 640 pages, of which about half consists of a report of lectures delivered at the Sorbonne in 1899 on the still more recent improvements of Maxwell's electrodynamic theory which are associated largely with the name of H. A. Lorentz. It is this latter half of the book, giving the writer's reflections and criticisms on a development which is still fresh, that will naturally present the chief interest for others who have meantime been following the progress of the subject.

The main feature of the new standpoint is the resuscitation of the idea of electricity as representing something permanent like matter. In Maxwell's later writings, in which he was mainly occupied in eliminating the hypothetical illustrations and models which had guided him to his theory, but were not logically necessary to its formal exposition, there was a tendency for the older idea of an electric charge, as representing something real, to be eliminated. According to his view, the electric current always flows in closed circuits like a current of an incompressible fluid, so that there is nowhere any tendency to accumulation of electrodynamically effective electricity. It seemed, therefore, possible to do without any introduction in detail of an entity whose flow was restricted by the condition that the quantity of it in any given volume could never alter. This conception of circuital electric flow (to use Lord Kelvin's term) required the ascription of properties the same as those of currents to electric excitation both in dielectric material substances and in the free æther itself. The displacement current thus introduced is, in fact, the fundamental feature of Maxwell's electrodynamics. Its assumption led directly to a simple and perfectly complete theoretical account of the electrodynamics of material systems at rest, on the basis of laws established long before by Ampère and Faraday; the application to bodies in motion was, however, left by Maxwell in an incomplete and tentative state. In 1872, when he published his treatise, the circumstance that the laws of electrolysis imposed the idea that electricity was in some sense or other atomic was definitely realised, but with a certain reluctance; while in the treatment of bodies in motion the explicit recognition that a moving charge acts as a current had, owing to an oversight arising from his preoccupation with the medium, to be formally introduced into his equations by Fitzgerald ten years later, though Maxwell fully accepted such action as a fact all the time.

This plan of ignoring electricity and treating electrodynamics on the basis of a uniform medium with physical constants affected by the presence of matter, and subjected to various vector disturbances whose nature is unknown, but which are connected by partial differential relations expressing the laws of Ampère and Faraday, has been very fully developed by Heaviside and by Hertz. In both cases compensation is sought for the variation of the energy of each element of the medium, solely in the work of tractions exerted on its surface by the surrounding parts. In Heaviside's discussion the problem was treated with great generality and comprehensiveness; it will suffice here to pass in review the salient features of the more concise analysis advanced by Hertz. The treatment of stress by the method of energy requires displacement of the medium; and so the problem of ponderomotive forces becomes related to the general question of moving media, which is the part of the subject that provides the crucial tests of theory. The electromotive phenomena in media at rest are, on the other hand, all involved in the adoption of the aforesaid laws of Ampère and Faraday, as a description of the properties and behaviour of the medium. The same description is extended to media in motion after the manner of Faraday, and the deductive part of the argument is there confined to the determination of the ponderomotive mechanical forces. To obtain them, Hertz subjects his single uniform medium, which he takes to be the seat of the electric and magnetic energy, to static strain without finite motion, and computes the time-rate of alteration of the energies thereby produced in a given element of its mass. He supposes that the polarisations per unit volume, being affections of the medium, are simply convected along with it. If the element of mass were dynamically self-contained and not subject to tractions from the surrounding parts, its energy would be conserved so that this time-rate of alteration should vanish. As it is, the alteration does not vanish, but represents the work done in the element by the tractions acting on its surface. As the element is part of an elastic medium, the work of such surface-tractions ought to be expressible in the form of work of the stress-system, existing in the element, to which these tractions belong. Now the expression for the variation of the energy is thrown by Hertz into the latter form, in fact without the use of any electrodynamics in the analysis; and this leads him at once, for the case of isotropic media, to a self-conjugate electromagnetic stress-system, the same as Maxwell's, as providing the reacting mechanical forces required for equilibration of the outstanding energy. But for æolotropic media there arises a bodily torque in addition to this stress; this torque is included in Maxwell's general type of magnetic stress, and prevents it from being self-conjugate for that case. Hertz is unwilling to admit such a type of stress, which could not exist in an ordinary elastic solid; but he is at a loss to know what to do with this new part, and simply drops it, retaining the self-conjugate part as the stress in his electric medium. But for this the theory would be a consistent one on his premisses; and the result for the free æther, or wherever there is no material polarisation, is, in fact, the stress which Maxwell showed was competent to represent the actual mechanical forces. It is to be observed that this is all that is to be got out of the statical application of the principle of energy to his medium; the kinetics of the electromotive play being assumed as known, outstanding variations of the energy in slow changes are to be ascribed to the work of mechanical forces. No success has been achieved in the problem of reducing the electromotive play in media in motion to definite self-contained dynamics on any other basis than the theory of electrons; the charge must consist of discrete independent elements, each with its own electric field. The mode of treatment here sketched introduces, among other things, a mechanical force of an electric field on changing magnetic polarisation as the counterpart of the known mechanical force of a magnetic field on changing electric polarisation; this, on the theory of electrons, is non-existent.

The treatment of electrodynamics on the basis of discrete electrons is a branch of statistical molecular theory, like the kinetic theory of gases, and involves the refined considerations connected therewith, including the estimation of averages instead of the following out of individuals. The care that is thus necessary in the analysis may be illustrated by a temporary slip that has crept in at the beginning of the discussion of Lorentz's theory (§ 333), in which the single principle of continuity of flux of true electricity appears as a consequence of the addition of two independent formulæ, (3) and (4), neither of which appears again. They cannot be both true, or there would be two such principles of continuity instead of one. It would seem that the term density has been inadvertently used in two different senses, ultimately as the volume density of electric charge in the medium which depends on how closely the electrons are packed in it, but meanwhile as the density of electricity in an electron, supposed to be itself a small and rigid though mobile volume-distribution of charge. This local oversight, doubtless due to imperfect reporting of the lectures, illustrates an actual disadvantage of a completed hypothesis, which insists on a full specification of an electron, over the less complete physical specification, which, recognising that there is more in the constitution of the molecule of matter than our philosophy may ever reach, is content to regard it simply as the unknown central point or pole of its surrounding field of force.

The general plan of development of electrodynamics on this basis that is adopted by M. Poincaré consists in writing down equations of motion for each electron, by assigning to it a mass and considering it to be acted on by the averaged or smoothed-out electric and magnetic forces of the field that surrounds it, and finally passing to equations for the medium in bulk by summing or averaging the results for all the electrons per unit volume. This method is in keeping with the astronomical traditions of mathematical physics, in which the problem is put in definite terms at the beginning, and the analysis is confined to surmounting the difficulties, purely mathematical, that arise in its unravelment. There is, however, a different kind of theoretical physics which has had more success in this country, which recalls the names of Young, Stokes, Kelvin and Maxwell, and has more recently in Germany been illuminated by the example and inspiration of Helmholtz. Care is taken to avoid an irrevocable formulation of the problem in advance, only its broad dynamical features being worked in; while all the light that cognate but better understood branches of physics can shed by way of illustration or analogy is pressed into service. Thus, instead of writing out isolated equations of motion for the ideal case of a single electron—on the tacit assumption that no other electrons are near which would disturb the averaged field that is alone supposed to affect it—it is recognised that electrons, possibly in very large number, are somehow involved in the structure of each individual molecule, and that the fundamental and essential element in the physics of matter in bulk is this permanent molecule considered as a single free vibrating system, with free periods producing a radiant spectrum, which are involved in the intrinsic mutual influence of these oscillating electrons. The simplest type of framework for the structure of such a system is to assume provisionally a gyrostatic orbital constitution of some kind, which assists in holding its parts together in some such way as the whirling motion holds together a vortex ring in fluid. Our dynamical plan is thus now no longer fixed, but flexible; in fact it must remain so until we can form a definite representation of such a molecule instead of only a general idea of it. Yet the uniformity of physical law for matter in bulk shows that we ought to be able to develop our synthesis without waiting for such knowledge, which may even quite possibly be unattainable. In this procedure we must attend primarily to such activities of the molecules as can be cumulated by addition, so as to produce aggregate results expressible per unit volume of the medium, and eliminate the remaining non-cumulative disturbance which is related to practically irreversible or thermal phenomena. Of the former class is the strain in the configuration of the molecule produced by the electric or magnetic field in which it is situated, this distortion being represented for statical purposes by a single vector quantity, the induced electric or magnetic moment of the molecule, which aggregates into induced polarity of the material medium. Such, also, are the types and energies of free vibration about the steady configuration, which have been analysed in their aggregate into definite periods by the spectroscope. Here our knowledge is related to general principles rather than special systems, and progress is possible, thanks to the purely abstract general formulation of dynamics by Lagrange and Hamilton, and also to the supports and signposts afforded by such phenomena as anomalous optical dispersion and the magnetic subdivision of spectral lines. Outside such properties our power of tracing relations is very limited and imperfect, in the absence of control over the individual molecules, there being little to go upon except the two principles of thermodynamics, those of energy and entropy. The difference between the two points of view, the definite but partial and limited mathematical illustration and the wider but largely undetermined model, crops up, for example, in M. Poincaré's discussion of conducting media (§417), in which the combination of polarisation with conduction arising from wandering ions does not appear to suggest itself: "remarquons d'abord qu' ayant affaire à des conducteurs on n'a plus de polarisation," so that he has only to deal with electric current and electric density, doubtless in some degree with a view to save complication in a didactic exposition; whereas from the other more physical representation of a material medium one does not readily conceive a state of affairs in which only conduction and convection of free charges are present, but would proceed rather to examine under what circumstances polarisation can be practically neglected in comparison with conduction. This, of course, can be done in ordinary electrodynamics, as was doubtless in the writer's mind. But in the optical phenomena of metals it was recognised by Maxwell himself from the earliest stages—thanks mainly to the physical models on which he cultivated his ideas—that both agencies were essential; while recent closer examination has shown (cf. *Phil. Trans.*, 1895 A, p. 711, and in detail in recent papers by Drude) how naturally their combination represents the general features of metallic reflection as revealed by the most valuable and extensive measurements of Drude and other experimenters.

In working out the analysis, our author follows Lorentz in calculating directly the electrodynamic effects propagated from the moving electric charges which are the source of all the disturbance. He expresses this in terms of the "retarded vector potential" of the true current, a vector whose components are the potentials of the three components of its distribution, considered, however, as travelling out from them and becoming established around them with the velocity of radiation. A procedure which concentrates attention on the simply extended though molecularly constituted medium, to the exclusion, as far as possible, of the individual moving electrons, can get on more simply in Maxwell's manner by using the fictitious total current, which includes æthereal displacement as well as translation of charges; then the retardation of the vector potential is dispensed with, and all the functions are referred to the same instant of time, so that attention can be concentrated on the processes of averaging, undisturbed by mathematical complexities.

The distinction above sketched between the crystallised mathematical and the fluent physical point of view is at the root of what is a prominent characteristic of the writer's criticism. The development of electrodynamics appears as split up into so many independent and largely irreconcilable theories; there are headings, "theorie de Weber, de Maxwell, de Helmholtz, de Hertz, de Lorentz, de Larmor." Whereas on the view which works by models and general ideas rather than by formulas there is but one theory of electrodynamics—at any rate only one æther-theory—which has put on various modifications and has adopted various forms of expression, in the course of gradual improvement so as to become a closer and closer mental picture of the orderly course of phenomena; the subject presents itself rather as a continuous historical development, into which somewhat different paths all converge, than as a series of competing modes of explanation.

There is one feature in M. Poincaré's exposition for which the English reader will be grateful. A considerable trouble in the assimilation of mathematical investigations on this subject is the diversity of the notations (not to speak of systems of units) that are in use. All the available letters of most available alphabets have been pressed into service to represent the numerous types of quantities that occur; and if there is not a consistent basis of usage it must follow that the same symbol will be made to represent different things by different writers. M. Poincaré has kept as close as circumstances allowed to Maxwell's own notation, thereby acting up to the appeal of Boltzmann ("Vorlesungen über Maxwell's Theorie," 1891, preface), who found it necessary to actually construct a key for his own use to connect the notations of the principal German writers. Although the simplifications introduced by Heaviside, and subsequently in more formal guise by Hertz, did much to clear away the unessential accumulations that had overlaid Maxwell's theory, they did not in any sense transform it; and recent developments may be held to have justified the superiority, as a working basis for further advance, of the original elastic framework in which Maxwell set the theory, over the condensed *précis* of established results by which Hertz temporarily replaced it. It seems, therefore, unfortunate that the condensation of notation which was a part of Hertz's modification should have reacted to introduce some confusion in the notation of the more complete theory.

The development of electrodynamics, which was firmly established as the proximate foundation of all physical science, certainly of all that has relation to the æther, by Maxwell about forty years ago, has been going on with rapidly accelerated progress, both on the experimental and on the theoretical side, during the last ten years. New points of view have rapidly come up, have sometimes been as rapidly transcended. It is not surprising, therefore, that the discussion in the last chapter, which mainly relates to the mechanical and *quasi*-mechanical models of the British school, is somewhat out of date, indeed, it is largely constructed on the basis of an abstract, published in advance, of an imperfect first draft of theory contained in a memoir of date 1894, much as a palæontologist reconstructs a fossil organism from some of its bones. In the recent Lorentz-memorial volume M. Poincaré has himself revised some of his positions.

It is by this sort of discussion that crude theories are sifted and worn down into symmetry and order. And it is matter of congratulation that an analyst of M. Poincaré's vast command of all the resources of modern mathematics finds time not only to apply his genius to a thorough revision of the methods of mathematical astronomy, but also to survey the field of general physics as he has done in this interesting volume. In these days of extreme specialisation such surveys promise a special harvest, but few have sufficient breadth of learning to undertake them. The modern development of the theory of functions arose largely from transplanting the ideas of flux and force of physical mathematics into purely abstract problems. In astronomy, M. Poincaré's work has partly repaid the debt; it remains to be seen whether in electrodynamics a further instalment will be repaid, or analysis again become the debtor.

Anyhow, while pure analysis is ramifying into vast new regions and becoming more and more specialised, it is fortunately still possible for a single person to acquire an effective knowledge of the whole domain of theoretical physics. As in literature, so in scientific exposition, the saving virtue is style. If we call to mind the history of any of the theories which form the established heritage of common knowledge—such as hydrostatics or pneumatics—in their early inception they presented just as complex problems as the theory of the æther does now. But by the efforts of successive generations of expositors they have gradually been worn down, and the artificial appliances of symbolic reasoning have been eliminated or illuminated by the cultivation of new ideas and modes of expression. A theory of the æther hardly existed in any adequate sense half a century ago. Progress has recently been so rapid both on the purely scientific side, and in the reaction of modes of thought that have been fostered by industrial developments, that in a short time we may be able to picture to ourselves the operation of the æther with as much clearness and directness as we now understand the functions of the atmosphere. J. L.

GILBERT WHITE OF SELBORNE.

The Life and Letters of Gilbert White of Selborne. Written and Edited by his Great-Grandnephew, Rashleigh Holt-White. Two Vols. 8vo. Pp., Vol. I., xv + 330; Vol. II., ix + 300. (London: John Murray, 1901.) Price 32*s.*

The Natural History of Selborne. By Gilbert White. Pp. vii + 381. (London: J. M. Dent and Co.) Price 1*s.* 6*d.* net.

NOTHING nearly as good as Mr. Holt-White's book has ever yet appeared about Gilbert White; it supersedes Bell's two volumes, to which we have so far had to go for the real characteristics of the great naturalist, and it is hardly possible that it will ever itself be superseded. In its skilful treatment of materials it is amply worthy of its dedication to a great scholar, the present Provost of White's College. The editor has been content to let White and his correspondents speak for themselves, but rarely interposing to set us right on some misconception, or to explain (often, it is clear, after much expenditure of time and trouble) who are the persons referred to in the correspondence; and the result is one of the most delightful stories of a quiet life ever told in our language. As we reluctantly close the second volume, we feel that we now know White perfectly well as he really was. There is no need for a reviewer to anticipate the pleasure of readers by attempting to copy the picture.

It should be said, however, that this is not only a book for naturalists or lovers of nature, but for readers of every kind. Indeed, the charm of it seems to lie chiefly in the picture of life and manners it gives us—of the life of quiet country folks, with sedate but real interests of their own, using their time well, and sharpening their faculties continually under the gentle and unconscious stimulus of their alert and keen-eyed neighbour, friend or uncle. Gilbert White is the centre of the group, and he seems to be setting all the members of it at work on something. He lets drop a hint, asks a question, administers a very gentle reproof, and the recipients of his letters treasure them up, and must, we feel, have acted on them.

One or two points of special interest may be noted here. It is very pleasant to find that Mr. Holt-White has been able to prove conclusively the falsity of the traditional Oriel notion that White retained his fellowship when he should not have done so. The four or five farms which he inherited brought him hardly more than a hundred a year; and towards the end of his life his relations with his College seem to have been quite cordial. It is, of course, natural that in a College where Fellowships were few in number, yet open to competition from the whole University, the locking up of a Fellowship for fifty years should at the time have roused a certain amount of criticism; but that criticism was made under the impression that White was a wealthy man, and to revive it, as it has been revived, in these days, is to do White a serious injustice. The Oriel of that day may be said to have endowed science unconsciously as it has never done since; for White, though not a man of science in the modern sense, has had a powerful influence in stimulating scientific habits.

Among the many delightful treasures in this book must be mentioned the letters of Thomas Mulso, now published for the first time—letters as bright, witty and natural as any that have ever been printed; and the two letters of Montagu, written after the publication of the "Natural History of Selborne," which offer a curious contrast, in their intense and almost feverish ardour, to White's quiet and leisurely way of going about his work. But perhaps those who love the eighteenth century and all its ways will find their greatest pleasure in the enthusiastic diary of Miss Kitty Battie, a visitor at Selborne. Little did that happy girl know that her notes, jotted down in the fulness of a grateful heart, would be treasured more than a century afterwards by readers as enthusiastic as herself.

Let us hope that this work, undertaken by a member of the White family, with full access to all records, and with the invaluable aid of Prof. Alfred Newton, may permanently satisfy all who wish to know about White's character and habits.

The second book mentioned at the head of this notice is a handy little volume in small octavo, which can be carried in the pocket, and has the great merit of being free from unnecessary notes and still more unnecessary illustrations. The few notes which it contains, by Mr. Charles Weekes, are at the end of the volume, and seem to be for the most part accurate and to the point. The text is reprinted from the first edition of the "Natural History," with a few slight alterations in spelling, which might perhaps have been dispensed with. If, for example, White wrote "plowed," there is no reason at all why an editor should substitute "ploughed." And it is a pity that the editor, in prefixing a few lines of Richard Jefferies' to the book, should not have spelt his name correctly. But on the whole the edition is a good one; far better, in fact, than many of much greater pretension.

COSMOGONY AND EVOLUTION.

Entstehen und Vergehen der Welt als Kosmischer Kreizprozess. Auf Grund des pyknotischen Substanzbegriffes. Zweite und erweiterte Auflage. Von. J. G. Vogt. Pp. viii + 1005. (Leipzig: Ernst Wiest, 1901.)

A REVIEWER can scarcely be expected to read the whole of the thousand and odd pages which Herr Vogt has required to express his views on the origin and decay of the world. As one looks down the table of contents, he feels that it would require a mathematician, a chemist, a physicist, a biologist rolled into one to do justice to the many various subjects which here come under notice, and if oppressed with this view he begins with the "methodologische" introduction and struggles with the adjectives, "fearfully and wonderfully made," he may be tempted to turn for a little relaxation to the "explanatory illustrations" scattered through the text. One of these (p. 260) is to explain the genesis of the solar system. The author gives some account of the cosmogony of Kant and Laplace, and recalls some of the objections which have been urged against these views. He is particularly severe on the insufficient explanation offered for the density of the planets closest to the sun. Saturn, he states, retired from the ring-making process when the mass of the ring was 1/118 of its own mass; while in the case of Mercury the sun continued to produce a ring the mass of which is only 1/4,316,550. The evident distaste of Saturn to form rings of smaller mass leads the author to abandon the ring hypothesis altogether and to offer an alternative theory. He conceives spheres of operation (Wirkungssphäre) and Deformierungssysteme (not so easily translated). But if we will imagine three circles, the centres of which form an equilateral triangle and each of the circles touches two others, the circles will form "Deformierungssysteme," while the enclosed triangular space bounded by the three circles is a "field of operation." Now in the small space near the points of contact we get the smaller planets formed, Mercury and the earth on one side and Mars and Venus on the other, each planet touching two circles and the next larger planet. Jupiter in this way has room for his giant bulk, pushing Saturn a little on one side, but otherwise is not inconveniently crowded. Of course, the whole merit of such a cosmogony depends upon the "Deformierungssysteme," and for the manner of working these the reader must be referred to the book itself. The second diagram (p. 949) is to illustrate the precession of the equinoxes. Here one would say there is no room for imagination; we have to do with a problem in rigid dynamics which is susceptible of but one explanation. But if any one thinks this, he has not reckoned with Herr Vogt, who, as a man of ideas, begins at the beginning. Before attempting to explain the cause of any modification in the position of the polar axis it is necessary, he tells us, to understand the laws which determine the constant position of that axis. These laws he proceeds to unfold on "phoronomische" principles, and in his endeavour to follow the author in these same principles the student will be not a little startled to find it necessary to project the plane of the Milky Way on a diagram to explain precession. But he will probably not read beyond the following sentence :—

"The North Pole describes a circle on the sky in about 26,000 years. We can call this circle the projection circle of the absolute orbit of the earth, therefore indirectly the solar orbit, and denote these 26,000 years as the period of the sun in its orbit."

After this one is not surprised to learn that the sun will have a more or less intensive effect on the tension of the æther according to its position in this orbit, and thus to be led to a satisfactory explanation of the phenomenon of the Ice Age.

Herr Vogt is to be congratulated on having found a publisher willing to express these views in a book of handsome appearance, and when one learns that an earlier edition has long been exhausted he is tempted to doubt whether German education is of the elevated character that is sometimes represented. W. E. P.

OUR BOOK SHELF.

The Geological History of the Rivers of East Yorkshire. By F. R. Cowper Reed, M.A., F.G.S. Pp. vi + 103. (London: C. J. Clay and Sons, 1901.) Price 4*s*. net.

SINCE Jukes, some forty years ago, explained how rivers cut through escarpments, the origin of their valleys has been well understood in a general way. Much, however, remained to be learnt about the development of particular rivers and the changes which have brought about present drainage areas; and these subjects have been so attentively and successfully studied by American geologists, notably by Prof. W. M. Davis, that their methods of interpretation have been followed by several observers in this country. The present work by Mr. Cowper Reed gained the Sedgwick Prize Essay for 1890, and is a capital exposition of the evolution of the rivers in East Yorkshire. After giving a general account of the various formations, he points out that the original "constructional surface" on which the present river system was initiated, was a plain formed by the Chalk and other Upper Cretaceous strata, and was upraised in early Tertiary times and perhaps partially eroded during the uplift. Having a greater elevation in the west, the direct ancestors of the present rivers took rise from the higher grounds and flowed eastwards, the Tees and Esk forming one river, the Swale and Ure flowing also direct to the coast, which formerly extended much further eastward, and the Nidd, Wharfe and Aire uniting and flowing out by the Humber. A long period of subaërial denudation followed the initiation of these consequent streams, there was a gradual lowering of the area, and there arose the subsequent river Ouse, which captured the Swale and Ure, the Nidd and Wharfe, conducting their waters into the Humber drainage. Towards the close of the Oligocene period, when the area had been nearly reduced to base-level by the formation of an extensive peneplain and the rivers had attained old age, there was considerable upheaval, accompanied by further movements along pre-Cretaceous lines of flexure, especially in the Moorland range of the Jurassic region. The rivers thereby regained youth and activity, their directions were locally modified, and thus were produced some of the main features in the present topography. Further changes, however, led to other modifications; there was depression towards the close of the Pliocene period, and subsequent elevation in Glacial times. With regard to the Boulder Clay the author judiciously remarks that "the land-ice theory appears to offer fewer difficulties than any others and to explain matters more satisfactorily." In any case large tracts, excepting some of the higher grounds, were buried beneath drift deposits, and the valleys were choked up. When the land had lost its icy mantle, some of these old valleys were revived, but in other cases the streams followed new courses. The story of all these changes is clearly told by Mr. Reed, and although there is room for difference of opinion in matters of detail, the main results are based on fact; and the essay may be profitably studied by those interested in the origin of our scenery.

Fergusson's Surveying Circle and Percentage Tables. By J. C. Fergusson, M.Inst.C.E. Pp. 84. (Published by the Author, 1901.)

THIS is an account of a device intended to replace the dial or circles in magnetic compasses and surveying instruments, with numerous illustrations of its application for the purposes of engineers, surveyors, naval and military officers and travellers. Half of the circle is divided into octants, and the graduation of each octant is effected by dividing its tangent, which is equal to the radius, into 100 equal parts and then drawing lines from these divisions to the centre of the circle. The divisions on the octant thus always subtend equal spaces on an offset laid out at right angles to the quadrantal radius. The spaces on the octant divided in this manner correspond to a hundredth part of the radius, and the angles being read in percentage divisions, trigonometrical formulæ are replaced by simple arithmetic. A considerable simplification of several practical problems is suggested by the examples given, but the advantages of the method can scarcely be judged without actual experience. It is stated, however, that many distinguished engineers and surveyors have expressed complimentary opinions as to its merits. Messrs. T. Cooke and Sons are the manufacturers of the new circle, which can be adapted to old or new instruments.

How to Know the Indian Ducks. By F. Finn. Pp. iv+101. (Calcutta: Thacker, Spink and Co., 1901.)

IF the right to include under the name of "ducks" both geese and swans be conceded to the author (and we have some doubt whether it should be), we have nothing but commendation for this excellent little volume. Years ago, when duck-shooting on the Ganges, we have a vivid recollection of our own regret at being unable to identify all the various representatives of the duck tribe included in our "bag," and we have little doubt that this regret has often been shared by other sportsmen. For the future, however, there should be no difficulty whatever in determining the species of any member of the tribe which may fall to the gun of the sportsman in India, as Mr. Finn's volume is small enough to be carried in the pocket without inconvenience, while the lowness of its price brings it within reach of every one. Needless to say, as the author is an accomplished ornithologist who has devoted special attention to the Indian Anatidæ, the descriptions are all that can be desired from a scientific point of view, while the simple language in which they are written, and the useful "keys" for the identification of species, render the volume admirably adapted to the needs of sportsmen.

It is for this class, indeed, that the work is primarily intended, as the author tells us in his preface; and the fact that the substance of the text has already appeared in the form of a series of articles in the columns of the *Asian* newspaper bears testimony to its favourable reception by Anglo-Indian sportsmen.

On more than one occasion we have directed attention in these columns to the confusion caused by the diverse systems of nomenclature followed by ornithological writers. In the present instance we are glad to see that the author endeavours to promote uniformity in this respect by following the classification and nomenclature adopted by Mr. W. T. Blanford in the "Fauna of British India." R. L.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

On the Determination of Positions in Polar Exploration.

HAVING in view the importance of this subject in connection with the forthcoming Antarctic expedition, a brief comment on the results obtained in high latitudes, with which we have been favoured during the last few months, may not be out of place. The publication of the scientific results of the Nansen expedition is now before us, and these, together with a few which (without further explanation perhaps) scarcely merit the employment of this adjective, and which are to be found in the pages of Mr. Borchgrevink's account of the *Southern Cross* expedition, afford food for reflection, but whether they could be more satisfactorily dealt with by a professional man of science or a professional humorist may be open to question. The first have resulted in a series of deductions and suggestions which will strike thoughtful men as being eminently unpractical, and the latter is responsible for considerable confusion of mind in regard to the geographical positions of the most important points to which the expedition just about to start is instructed to proceed.

These being for the moment the more important, may be dealt with first. It has already been pointed out by NATURE that the recorded observations of the Borchgrevink expedition are extremely unsatisfactory, owing, possibly, to the work of a copyist ignorant of nautical calculations, but besides being improperly copied they are improperly computed. One, owing to the use of the secant of an erroneous latitude, is made to produce a longitude 22′ in error. Another computes the declination with a correction for longitude instead of for the Greenwich date. A third professes to find the chronometer error to a couple of seconds by a lunar eclipse (a feat which, if true, is miraculous); and a fourth produces a longitude of the harbour under the great ice barrier from which Mr. Borchgrevink effected his landing which is said by the navigating officer to be 164° 32′ W., by the commander 164° 10′ W., and by the president of the Royal Geographical Society 162° 30′ W.

The position of Cape Adare, again, is of the very first importance. Ross placed it in 71° 18′ S.; Mr. Borchgrevink finds this latitude correct, but places it 36′ further to the East; while Sir C. Markham, if we may judge by the *Geographical Journal* for July, has apparently been informed that it lies in lat. 71° 30′ S.

Much satisfaction has been expressed at the supposed verification of the position of two groups of islands (the Balleney groups), but much astonishment has also been expressed by thinking men that the Geographical Society can attach the faintest importance to the determination either of their number or their position by officers who, in discussing the subject, contradict each other flatly both as to the date, the appearance and the distance of the land at the time of the discovery; to say nothing of the suggestion that at distances ranging from 90 to 40 miles abundance of detail, including crevasses, and the shore line were plainly visible.

Turning to the scientific results of the Nansen expedition, and having in view the remark of your reviewer (NATURE, June 13), that the volume is to be welcomed as exceedingly opportune in view of the approaching Antarctic expedition, I should like to call the attention of the scientific staff to certain information which they may find it interesting to put to a practical test. It is here suggested:—

(1) That the value of refraction can be estimated from astronomical observations taken during a drift, when the latitude by which the altitudes are computed depends upon the unknown refraction and the refraction upon the unknown latitude. (See table of refractions).

(2) That the altitudes necessary for the computation of a lunar distance can be calculated by a man having no knowledge of his Greenwich time and being uncertain of his longitude to the extent of from 15 to 25 degrees. (See Nansen's lunar, taken August 10, 1895).

(3) That the discrepancy between two sets of altitudes taken, the one with a glass horizon labouring under suspicion and the

other with a pocket sextant and ice horizon, justify the conclusion that the terrestrial refraction was so abnormal, that the computation of the latitude necessitated the reversal of the sign of the dip; but that this state of things was local, and that the observations of another observer only ninety miles away would not be so affected, though the temperature and general conditions were in both cases practically the same. (See comparison between the corrections for refraction in the meridian altitudes of Nansen at his Farthest North, and Hansen on board the *Fram*, April 6, 1895).

Admitting to the full the truth and justice of the remark of your reviewer in connection with the observations taken during Nansen's sledge expedition, that "the fact that observations were taken at all is the strongest possible evidence that scientific zeal is compatible with the possession of remarkable courage," it must also be admitted that a comparison of these scientific results with those which Nansen obtained from the same times and altitudes proves that scientific zeal and the power of taking observations are also compatible with the inability to comprehend the very elementary fact that if the results of two or more observations differ widely from each other neither is trustworthy, and that geographical positions and condemnations of the work of such men as Julius Payer and Wyprecht cannot, and ought not, to be based upon them.

Should any student of practical nautical astronomy go to the trouble of making this comparison, he cannot, I think, fail to perceive at every step that, however painstaking Prof. Geelmuyden and his colleagues have been in their attempt to plot Nansen's route on his celebrated sledge journey, they have been compelled to ignore his own statements and his own workings, and while straining at the scientific gnat they have freely swallowed the practical camel. Dr. Nansen had led us to believe that the scientific results would explain and justify his already published results. It can be easily shown that one or the other is hopelessly wrong. They are totally irreconcilable. If it is for one moment admitted that Nansen had the opportunity and ability to work the common observation for longitude by chronometer, then Prof. Geelmuyden's primary hypothesis is unsound. If it is maintained that that hypothesis is even approximately correct, Nansen's own recorded results become ridiculous.

Turning from matters of fact to matters of opinion, two statements of great interest to explorers in high latitudes may be noticed. On p. 14 we are informed that one of the computers employed with advantage the difference of altitude near the prime vertical to determine the latitude. Now in low latitudes, where the change of altitude is rapid, say from 10′ to 15′ per minute of time, a result within five or ten miles of the truth is perfectly possible. In latitudes from 70° to 85° N., with altitudes changing at most 5′ or 6′ per minute of time, and affected by refraction abnormal in itself, and varying rapidly according to no well-defined law, the method entirely fails. If a chance observation appears to justify its use, the altitudes must be accidentally or miraculously correct.

The remark on lunars, p. 22, will strike experienced observers as exceedingly curious. "The results," says Prof. Geelmuyden, "are not satisfactory."

Table C., p. 44, shows that eight observations were taken at various times, and from them Greenwich Mean Time was determined with errors varying from 18 seconds to 2 minutes. On the assumption that the explorers might have been dependent on them, their positions would have been affected with a maximum error of 30′ of longitude, or about four geographical miles. Let future explorers note this. It may safely be affirmed that these results will seldom be surpassed by men taking lunars under Arctic conditions. It may with equal truth be said that for the purposes of such explorers greater accuracy is unnecessary; and the submission to a practical test of Prof. Geelmuyden's opinion, that better results can be obtained by deducing the moon's right ascension from the difference of azimuth of the moon and a star, will be a task not unworthy of the scientific expert accompanying the *Discovery*. E. PLUMSTEAD.

"First on the Antarctic Continent."

SOME rather venomous criticism of my book, "First on the Antarctic Continent," has appeared in one or two periodicals. Had my book been intended to be what it is not—a scientific report upon our work in the south—the venom would to some extent be justified. There are, however, other circumstances which prevented me from producing at the time a larger and more representative account of our work in the south. Preliminarily may I state that the observations have been submitted to the Council of the Royal Society, who have accepted them, and the Society is in due time going to publish a volume on the results? This speaks for itself of the efficiency of the staff I had chosen. The Natural History Museum of South Kensington has received the bulk of the collections and I understand that the report upon them is nearly finished, and the book, written by specialists of the Museum, will probably appear within a very short time. C. E. BORCHGREVINK.

(Commander, British Antarctic Expedition, 1898–1900).

Douglas Lodge, Bromley, Kent, July 5.

The Settlement of Solid Matter in Fresh and Salt Water.

IN a letter under the above heading in your issue of June 20, Mr. W. H. Wheeler discusses the effect of dissolved salt in promoting the subsidence of alluvial matter in water. He takes exception to the conclusion of Mr. Slidell that the mixture of sea water with river water exercises a preponderating influence on the formation of deltas. The question at issue is not one that can be settled simply by a consideration of the specific gravity and viscosity of the solutions employed, and Mr. Wheeler has made it the subject of experimental investigation. There can be little doubt that it is only in the case of very finely divided solid matter in suspension that the addition of salt solution causes increased precipitation, and so far his results can scarcely be called into question. They are confirmed by the investigations on the deposition of sediment by Carl Barus and Bodländer, to whose papers references are given below.

The precipitation of such "suspensions" or "pseudo-solutions" by the addition of an electrolyte is accompanied by the coagulation or flocculation of the solid matter. Schlœsing states that clay suspensions pass through a filter paper, but can easily be filtered if coagulated by a salt solution. If, however, the clay is washed free from salt, it can enter into suspension again in pure water and be precipitated afresh. These two operations can be performed in succession several times without apparent modification in the results. Picton and Linder found that the coagulum produced by the precipitation of a pseudo-solution of arsenic sulphide contained traces of the metallic ion, which could not be removed by washing.

The mud or ooze examined by Mr. Wheeler seems to have consisted entirely of matter which had already undergone precipitation, but it does not appear from his letter that any precautions were taken to remove traces of the metallic salts, so that it remains doubtful whether the sample really formed a suspension in the pure water. More satisfactory experiments could perhaps be made by collecting samples of turbid water from a river in flood and then adding sea water or a solution of salt.

I had occasion some time ago to consult the somewhat extensive literature dealing with the suspension of solid matter in a fluid and the allied one of colloidal solutions, and the following list of papers, though doubtless far from complete, may be of use to some readers of NATURE:—

Skey, *Chem. News*, xvii. p. 160; Waldie, *Chem. News*, July 24, 1874; *Journ. As. Soc. Bengal*, 1873; Th. Scheerer, *Pogg. Ann.*, lxxxii. p. 419, 1851, einige Beobachtungen über das absetzen auf geschwemmter pulverförmiger Körper in Flussigkeiten; Hunt, *Proc. Bost. Soc. Nat. Hist.*, pp. 302–4, 1874; Slidell, *Report* of Messrs. Humphreys and Abbott on the physics and hydraulics of the Mississippi, App. A, p. 11, 1861; Ch. Schlœsing, *Compt. rend.*, lxx. p. 1345, 1870, sur la précipitation des limons par des solutions salines très-étendues; David Robertson, Glasgow Geol. Soc. *Trans.*, iv. pp. 257–9, 1874; W. Durham, *Chem. News*, xxx. p. 57, 1874; *Chem. News*, xxxvii. pp. 47–8, 1878; *Proc.* Roy. Phys. Soc. Edin., iv. pp. 46–50, 1874; W. H. Brewer, *Proc.* Nat. Acad. Sci., 1883; *Amer. Journ.* (3), xxix., p. 1, 1885; C. R. Stuntz, Cincinnati Soc. Nat. Hist., Feb. 1886; E. W. Hilgard, *Amer. Journ.* vi., 1873, xvii., 1879, Forschungen auf d. Geb. d. Agriculturphysik von E. Wollny, ii. pp. 57–9, 441–454, 1879, ueber die Flockung kleiner Theilchen; A. Mayer, Forschungen auf d. Geb. d. Agriculturphysik von E. Wollny, ii. pp. 251–273; Hallock, *Bull.* of the U.S. Geol. Survey, xlii. p. 137, 1887; Carl Barus, *Bull.* of the U.S. Geol.

Survey, xxxvi. 1886, subsidence of fine solid particles in liquids, *Am. Journ. Sci.* (3), xxxvii. p. 122; Carl Barus und E. A. Schneider, *Zeitschr. f. Physik. Chemie.*, viii. p. 285, 1891, über die Natur der colloidalen Losungen; G. Bodländer, *Jahrb. f. Min.*, ii. pp. 147–168, 1893; *Götting. Nachr.*, p. 267, 1893, versuche über Suspensionen: Stanley Jevons, *Quart. Journ. Sci.*, viii. p. 167, 1878; Picton and Linder, *Chem. Soc. Journ.* lxi. pp. 114–172, 1892; lxvii. pp. 63–74, 1895; lxxi. pp. 568–573, 1897, solution and pseudo-solution; H. Schulz, *Journ. f. prakt. Chemie.*, xxv. p. 431, 1882; Hardy and Whetham, *Journ. of Physiology*, xxiv. p. 1899, *Phil. Mag.* Nov. 1899; Hardy, *Proc.* Roy. Soc., lxvii. p. 95, p. 110, 1900; W. J. A. Bliss, *Phys. Review*, No. 11, 1895 (2).

H. S. ALLEN.

Blythswood Laboratory, Renfrew, N.B., June 27.

The Teaching of Mathematics.

BEING myself a teacher of mathematics, I have followed with much interest the vigorous crusade against the neglect of suitable scientific and mathematical training conducted by Prof. Perry and others, and am in substantial agreement with Prof. Minchin's remarks in his review in your columns of the series of papers by Prof. Perry on "England's Neglect of Science."

One thing has struck me in connection with school "mathematical" teaching as being a very illogical course of procedure on the part of the dominant "classical cleric" instructors of youth alluded to—namely, the teaching of *arithmetic*. A boy, whether classically or otherwise educated, is considered a dunce if he is not merely not an expert with the multiplication table, but even if he is unacquainted with such things as recurring decimals, square and cube roots, &c., whereas no attempt is generally made to give an insight into *theory*, the results, *i.e.* the *rules*, are what he is expected to know.

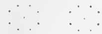
So dissociated to the ordinary mind is the science of arithmetic from mathematics that I can remember a fellow collegian actually remarking, "Mathematicians are bad at arithmetic"! It seems to me, on the other hand, that Euclid is much more out of the line of what we mean by mathematics. In teaching Euclid as a mathematical "subject," and, as some claim, as an introduction to geometry, we are actually raising barriers to the progress of a learner in grasping the meaning and uses of geometry. We insist on the propositions being learned *in all their cases*, insisting on the absolute distinctness of propositions which are merely particular cases of the same proposition, thus tacitly suggesting the existence of some such commandment as "Thou shalt not recognise the Principle of Continuity"—we ignore the infinite and we teach to try and wriggle away from the notion of a "limit." In fact, nearly all that really constitutes mathematics is carefully avoided in teaching of Euclid, whereas I have found, when I have dared once or twice to depart from examination ideals, how true the following remarks of Mr. C. Taylor in his prolegomena to "The Introduction to the Ancient and Modern Geometry of Conics" are. When referring to the work of Boscovich, he says:—"It is remarkable that Boscovich enters upon these abstruse speculations in an elementary treatise for beginners.... The preface to the volume contains an earnest plea for the introduction of the modern ideas into the schools. He had taught the appendix *viva voce* to his own tyros with the happiest results .... demonstrations are put before him (the tyro) in an unsuggestive form which gives no play to his inventive faculty; and thus it comes to pass that of the many students so few turn out genuine geometers ..."

I must not encroach further on your valuable space, although many points come to one's mind, such as the exclusion from so-called "higher algebra" papers of the theory of determinants, arithmetic without logarithms, applied mathematics without the calculus, &c., but, in hopes that the attack may be vigorously pushed home, subscribe myself yours sincerely,

Henry Smith School, Hartlepool. F. L. WARD.

Curious Rain drops.

ON Thursday last, July 11, about 6 p.m., the day having been sultry, the sky became dark and overcast, threatening rain. Only a few scattered drops fell, however (the threatened rain passing off), but these sparse rain-drops drew my attention by their curious appearance on the sill of the window near which I sat.

Each rain-drop had broken up into a number of smaller drops, which arranged themselves in a circular form around a central one, in the manner here shown 

Perhaps some one of your readers would kindly explain the cause of this, and if it was due to some electrical condition of the atmosphere. M. S.

Bowdon, Cheshire, July 14.

THE MYCENÆAN QUESTION.[1]

THE occasion for the following remarks on that difficult and much disputed subject, the Mycenæan Question, is furnished by the appearance of the timely volume on the "Oldest Civilization of Greece," by Mr. H. R. Hall, of the British Museum, and as public interest in the whole question has been considerably quickened by the important discoveries of Mr. A. J. Evans in Crete, this book, in which certain of the principal results of the Cretan excavations are discussed, will be heartily welcomed by the broad-minded school of classical archæologists in general, and by the student of ancient Oriental civilisations in particular.

It is now some twenty-five years since the spade of Schliemann brought to light the remains of the oldest civilisation of Greece; and as it was soon recognised that these remains belonged to the period of the Bronze Age, it was clear that they must be older than the classical period of Greek culture. The excavations which were made subsequently in several parts of the Greek world by the various investigators who were emulating

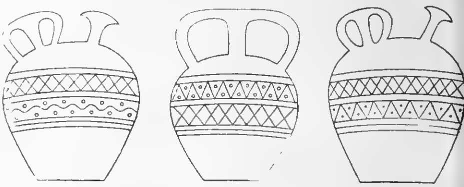


FIG. 1.—Representation of Mycenæan vases; from a fresco in the tomb of King Rameses III. at Thebes, B.C. 1200.

Schliemann's example proved that this Bronze Age culture was not confined to any particular part of Greece, but extended over the whole Hellenic area. Such discoveries compelled classical scholars to abandon many preconceived notions, and they found it necessary to revise entirely their ideas about the origins of Greek civilisation; it is not to be wondered at that many excellent scholars of the "old school" still find it difficult to make their views fall into line with the new order of things in classical archæology. This is most evident when the dating of Mycenæan antiquities has to be considered, for if the Mycenæan culture, being of the Bronze Age, is necessarily pre-classical, its *floreat* must be assigned to the second millennium before Christ. An important confirmation of this view seems to be supplied by the evidence derived from the excavations which have been made in Egypt in recent years, where a large number of objects, pottery, &c., of Mycenæan origin have been found; and in many cases such objects have been discovered side by side with native Egyptian objects which must belong to the period which lies between B.C. 1500 and B.C. 1000. The discoveries of Mr. A. J. Evans, however, all seem to point to a still earlier date for the first development of

1 "The Oldest Civilization of Greece: Studies of the Mycenæan Age." By H. R. Hall, M.A., Assistant in the Department of Egyptian and Assyrian Antiquities, British Museum. Pp. xxxiv + 346; with 76 illustrations. (London: D. Nutt, 1901.) Price 15*s*. net.

Mycenæan culture out of primitive barbarism, and a useful indication of its antiquity is supplied by the discovery, recently announced, of a statue of King Khian of Egypt, in Crete. Now the existence of King Khian was made known to us by numerous scarabs and certain monuments which were found at Tanis in the Delta and Baghdad in Turkey-in-Asia, and it is generally thought that he was a Hyksos king, who reigned about B.C. 1800. Prof. Petrie, judging from the style of the work on Khian's scarabs alone, has assigned this king to a far earlier date, *i.e.* to the period between the sixth and eleventh dynasties, about B.C. 3000; there is, however, no sufficient foundation for this view, and, so far as we know, it is not accepted by the majority of Egyptologists. The discovery of Khian's statue by Mr. A. J. Evans in the Mycenæan Palace of Knossos takes its place naturally in the long series of facts derived from archæological evidence collected in Egypt and Crete, which point with one accord to a date before B.C. 1500 for the beginnings of the Mycenæan period properly so-called.

FIG. 2.—Egyptian vase imitating Mycenæan form, about B.C. 1350. (British Museum.)

The first systematic arrangement of the evidence which was derived from the discoveries of Schliemann was embodied in the work "Mykenische Vasen," by Messrs. Furtwängler and Löschcke, to whom the classification of Mycenæan pottery is due, and an anticipation of the conclusions to which Mr. A. J. Evans' discoveries appear to tend in respect of the prominent part which the Cretans took in the early Greek civilisation was essayed by Dr. Milchhoefer, whose "Anfänge der Kunst in Griechenland" appeared about the same time. The position which Mycenæan archæology had reached about 1890 was well summed up in Dr. Schuchhardt's epitome of Schliemann's works, and in this book we already see the beginnings of an attempt to obtain accurate dates for the periods of the Mycenæan culture by means of conclusions drawn from results supplied by Egyptian excavations. Many of the available data employed by Dr. Schuchhardt and his successors were supplied by the excavations of Prof. Petrie at Kahun and Gurob, and above all at Tell el-Amarna, from which site conclusive evidence of the contemporaneity of Mycenæan culture with the heretic king Amen-hetep IV. and other monarchs of his dynasty can, *pace* Mr. Cecil Torr, be deduced.

But about this time attention began to be drawn to the remains of a pre-Mycenæan period of culture in Greece, and the discoveries of Prof. Dörpfeld at Troy resulted in a definite arrangement of the prehistoric civilisation of Greece in two well-defined periods, viz. the primitive or pre-Mycenæan, and the fully developed or Mycenæan Ages. The arrangement made by Dr. Dörpfeld became, in its turn, the base of a general sketch of Mycenæan archæology in the Mycenæan Age which was published in 1897 by Prof. Tsountas and Mr. Manatt, a work which, though based on Prof. Tsountas's earlier essay, was thoroughly revised and brought up to date in the light of the most recent research. This book, however, has one cardinal defect, and the evil effects of this defect are far-reaching: Prof. Tsountas, having arrived at certain conclusions, which from the nature of the case must be of a hypothetical character, states them as so many concrete facts instead of giving the reader to understand clearly that they are only his own opinions. Since

FIG. 3.—Bügelkanne of Mycenæan type made in Egypt, B.C. 1350. (British Museum.)

the publication of this book, however, Mycenæan archæology has entered upon a new phase, owing to the discoveries made by the British School at Athens on the site called Phylákopi, in Melos, and by Mr. A. J. Evans at Kephala, the site of the ancient Knossos in Crete, which have produced a mass of new and highly suggestive material for the archæologist to work upon; the results obtained from these excavations tend to indicate a comparatively high antiquity, *i.e.* about B.C. 1500, for the period when Mycenæan culture had attained its highest development. A different conclusion, however, seems to have been indicated as the result of the excavations which were carried out at Curium and Enkomi by Dr. A. S. Murray, of the British Museum, and his assistants, Mr. H. B. Walters and Mr. T. L. Myres, for the general evidence derived from the objects which they found in the course of their work shows that Cyprus continued to be included within the circle of Mycenæan culture as late as the ninth and eighth centuries before Christ. This date agrees with that assigned by Mr. A. J. Evans to the late Mycenæan treasure from Aegina which is now in the British Museum.

It has been necessary to make the above somewhat lengthy chronological statement on the Mycenæan question in order that the reader may be able to understand the exact position which Mr. H. R. Hall takes up on this disputed ground of research. He divides his work into eight chapters, which discuss the new chapter of Greek history generally, and the relation between the archæologist and historian in the elucidation of Mycenæan antiquities; the generally accepted Mycenæan hypothesis as modified by the latest discoveries; the questions of date and race; Mycenæ and the East and Mycenæ and Egypt; Mycenæ's place in history, including a discussion on the period of the introduction of the metals into Europe; and the decadence and renascence of Greek culture after the close of the Mycenæan period. The book contains in addition four appendices, seventy-six illustrations, full indices, notes, &c. Many of the facts which are given in Mr. Hall's book are familiar to us from other sources, but he has brought forward from the domain of Egyptology a considerable number which will probably be new to the majority of his readers; indeed, if we remember rightly, the Mycenæan Question has never before been handled by one whose training has made him familiar with both Greek and Egyptian archæology. His chapter, then, on the connection between Mycenæ and Egypt will be read with much interest, especially his remarks of the identifications of the northern Mycenæan tribes who attacked Egypt between B.C. 1400 and B.C. 1150. He has identified the tribe of the Uashasha with the Axians of Crete, and he has shown the probability that others of the tribes which are mentioned in Egyptian history at this period

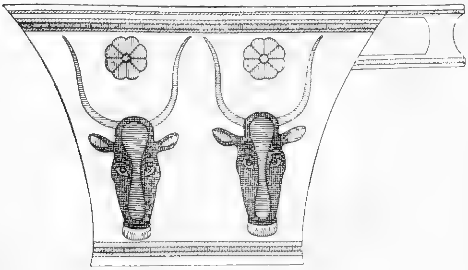


FIG. 4.—Representation of a Mycenæan metal vase from the tomb of Rekh-ma-Rā at Thebes, B.C. 1550.

were of Cretan origin, including the Pulesatha, or Philistines.

It has been noticed that many of the names of these tribes ended in "sha" or "na," and Mr. Hall has, with apparently very good grounds, identified these terminations with the common nominal suffixes "azi" and "ñna" which are found in the Lycian language and, seemingly, also in other cognate speeches of Asia Minor. Mr. Hall seems also to have devoted his energies to the solution of the difficult problem of dating the early antiquities of Greece, and, so far as we understand him, he takes in this respect a position midway between those who hold that the latest date possible in Mycenæan archæology is B.C. 1100 and those who hold, with Dr. A. S. Murray, that this date is more likely to be the *earliest* which can be assigned to Mycenæan antiquities, *i.e.* he believes that in Greece proper and in Crete the Mycenæan culture began at a very early period—which, however, he does not define exactly—and had already reached its highest pitch of development about B.C. 1500, when its chief seat was in Crete, and when it was extending its influence to Egypt and Asia Minor. He considers that the discrepancy between the two extreme views can be reconciled on the theory that in Greece proper the Mycenæan age came to an end about B.C. 1000, but continued to exist in Asia Minor until about B.C. 800, and in Cyprus until a century later.

This view is perhaps confirmed by the fact that the Dorians, who, *ex hypothesi*, overthrew the Mycenæan culture in Greece, did not reach Asia until about B.C. 800, and never gained any foothold whatever in Cyprus. Another important point made by Mr. Hall is that, contrary to the usually accepted view, iron was already known to the Egyptians about B.C. 3500, when, as he says (see p. 198), "it appears named and depicted on the monuments in a manner which admits of no possibility of doubt as to its nature." He supports his statements by quotations from a learned article by the Swedish Egyptologist, Prof. Piehl, which appeared in *Ymer* (1888, p. 94 ff.), from which it may be safely concluded that the Egyptians were acquainted with the use of iron some 2500 years before it came into general use in Europe. We notice that the passages which Mr. Hall quotes from Egyptian texts are translated by him especially for the purposes of this book, and he weighs with discretion the evidence which many would derive from the cuneiform and from the so-called "Hittite" inscriptions for the elucidation of the origins of Mycenæan culture. It is interesting to note that he believes it possible that the system of writing which was in use among the Cretans may have been derived from the Egyptian hieratic, and he points out some probable instances of the similarity between the two scripts; but, contrary to the opinion expressed by Mr. A. J. Evans,

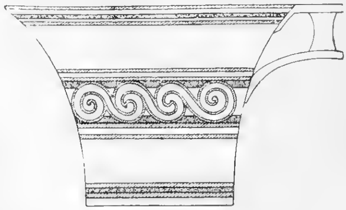


FIG. 5.—Representation of a Mycenæan metal vase from the tomb of Rekh-ma-Rā at Thebes, B.C. 1550.

he thinks that the writing is to be read from right to left, because the figures of men, birds, &c., which occur in it invariably face to the right, and should, on the analogy of Egyptian, face the beginning of the line (see p. 141). Still, it must not be forgotten that, chiefly owing to geographical difficulties, there cannot have been much direct communication between Crete and Egypt across the open sea in the Mycenæan period, and the connection between the two countries must have been carried out *viâ* Cyprus and the coast of Palestine; and it is a fact that the Cretan and other northern marauders who attacked Egypt in the reigns of Menephthah and Rameses III. made their way to Egypt by this route.

There are many other points of interest in the book to which we should like to draw attention, but our space is exhausted. The Mycenæan question is a difficult one, and one which, in our opinion, will not be settled for some years to come; the evidence which will bring about this result is accumulating, but there is not enough of it available yet. The most serious phase of the question as it now presents itself is the discrepancy between the dates assigned by experts for the beginning and end of the period of Mycenæan culture proper. Mr. Hall does not claim, if we understand him aright, to have settled this difficulty, but there is no doubt that he has collected a number of facts which will one day form valuable elements in the solution of the problem, and he has set forth the Egyptian aspect of the Mycenæan question in a clearer form than any of his predecessors. His volume contains an excellent summary of the work already done, and will give the reader a capital idea of the position of the workers in the Mycenæan field; it will also enable him to take an intelligent interest in the labours of future workers and to appreciate the developments of a most fascinating line of research.

THE SOUTH EASTERN AGRICULTURAL COLLEGE AT WYE.

THE new block of buildings just completed at the South Eastern Agricultural College at Wye, Kent, is to be opened by the Right Hon. R. W. Hanbury, president of the Board of Agriculture, as we go to press this week. As the College has been constituted a school of the University of London in Agriculture, it may be of interest to give a short account of this institution—one of the most advanced examples of the development of agricultural education under the administration of "the whisky money" by county councils.

The College began work in 1895, and is managed under a scheme of the Charity Commissioners by a governing body appointed by the county councils of Kent and Surrey, together with representatives of the Universities of Oxford, Cambridge and London, the Royal and the Bath and West Agricultural Societies. The buildings, which are situated at Wye, a little village on the South-Eastern line between Ashford and Canterbury, consist of a nucleus built about 1470, an ancient collegiate foundation due to the Cardinal Archbishop Kempe, with successive additions made in 1894 and the current year.

The old buildings form a small quadrangle with brick cloisters and include a fine and lofty hall, the refectory of the original College now restored to its original purpose, and a beautiful oak panelled room, which is used as the library. The later additions form a second quadrangle, with lecture rooms, &c., on the ground floor and students' living rooms on the first floor; the chemical laboratories occupy a further wing. There are two lecture rooms, one a theatre with raised seats accommodating 150 people; the drawing office provides working space for twenty-four students in such subjects as surveying, building construction and farm engineering. On the biological side there is a laboratory with working space for thirty students, furnished with Swift's histological microscopes; two smaller laboratories for the professors of botany and economic entomology, and a museum, of which the chief features at present are a collection illustrating the insect pests attacking fruit and hops, specimens illustrating the forestry course, pathological specimens in connection with farm animals, typical cereals, soils, &c.

FIG. 1.—Chemical Laboratory of the South Eastern Agricultural College.

The chemical laboratories consist of a general students' laboratory, measuring about 45 by 30 feet, lighted on both of the longer sides of the room; it is fitted with two double benches running longitudinally, reagent bottles being carried on glass shelves down the middle of the tables. The two benches give working room for thirty students, and other benches in the window recesses are provided for special work; water and gas are laid on to all the tables, and there are two fume chambers within and one outside the laboratory. Separated from the main laboratory by a glazed partition is the balance room and the larger of the analytical laboratories; adjoining this comes a smaller room reserved for gas analysis, titrations, &c., that require an acid or ammonia free atmosphere, and next to this comes a room for the furnaces and for ether extractions and other operations involving the use of inflammable liquids; in one corner of this room a drying chamber has been built.

The College farms about 250 acres of and adjoining it is preeminently a sheep farm, the soil being a light loam resting on chalk; the main features of the farming consist of a breeding flock of the Romney Marsh breed, a small dairy herd of shorthorns and a large stock of poultry. There is a small hop garden, planted in 1895, to test the various systems in vogue of training hops and for other experimental work. The two fruit plantations are both young; one is used for teaching purposes, the other is mainly laid out for experiments. On the farm are situated the dairy, forge, carpenter's shop, apiary, &c.

The staff of the College consists of seven resident professors and lecturers, together with instructors in practical subjects, demonstrators, &c., the necessity for this extensive staff being that the College is also a centre for much practical experience with the children of the Wye Elementary School.

At present there are some fifty to sixty students in residence, mostly taking the ordinary course, but a few are doing special work in the laboratories; it is hoped that such students will increase with the facilities the institution now affords for research which requires work both in the field and the laboratory. Both at home and in our Colonies and dependencies agriculture wants trained investigators and teachers if we are to keep our place, and the South Eastern Agricultural College is making a serious attempt to supply within the London University the kind of institution that has done such good service for American and German farming.

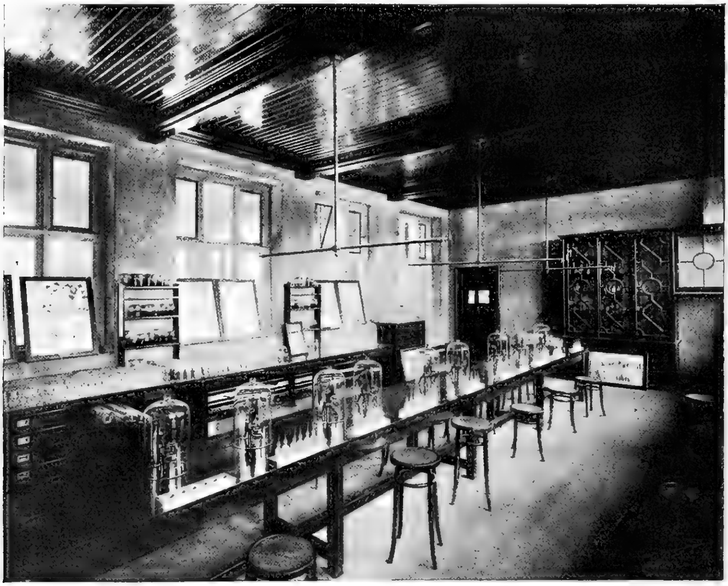


FIG. 2.—Biological Laboratory of the South Eastern Agricultural College.

extra-mural work in the counties of Kent and Surrey, such as courses of lectures, analyses of soils and manures, reports on crop diseases, field experiments and similar investigations. As regards the latter, experiments on the manuring and cultivation of hops have been carried on consecutively for six years, and results of considerable practical importance are beginning to emerge. Other work extending over several years has been done on the quality of barley as affected by manuring, the cost of growing sugar beet and its food value, and a systematic examination of the soils of Kent and Surrey has also been in progress for some time.

The normal course of instruction extends over two or three years; the College grants a diploma of its own, and with the constitution of a board of agricultural studies in the University of London it is expected that regulations for the degree course will soon be forthcoming.

Short sessions for special purposes are held from time to time; in August, for example, there will be a normal course of instruction in "nature knowledge" for elementary school masters, the outcome of two years'

THE BRITISH ASSOCIATION.

GLASGOW MEETING, SEPTEMBER 11-18, 1901.

IN the first article which appeared in NATURE on May 23, particulars were given regarding the local arrangements as to reception room, rooms for sectional meetings, and the halls in which the presidential and other evening scientific lectures were to be delivered. The Friday evening lecture is to be given by Prof. W. Ramsay, on inert constituents of the atmosphere, and the Monday evening lecture is to be given by Mr. Francis Darwin, on the movements of plants.

Two important fixtures by the Excursions' and Entertainments' Committee have been made since the last notice, namely, the chartering of one of the Clyde steamers for a whole day's sail on Saturday, September 14, and the acceptance of an offer by Lord Blythswood, president of the Philosophical Society of Glasgow, to give a garden party in the Botanical Gardens on the afternoon of Monday, September 16.

Promises of numerous papers by eminent authors are already received by the recorders of the different sections. Indeed, one or two of the sections generally get more papers than is necessary to fill the time of the sittings. For example, Section A not only meets on Saturday, but is also on two days actually divided into two subsections. On Friday it is to be divided into (1) physics, and (2) astronomy. On Monday it is to be divided into (1) mathematics, and (2) meteorology.

At this early stage a full and definite programme of the different sections cannot be given. But the following brief provisional programme may be taken as conclusively indicating that the meeting promises to be a most successful one from an educational and scientific point of view.

Section A (Mathematical and Physical Science).—A large number of papers are already promised for this section. The following may be mentioned:—Five papers, dealing with elasticity, viscosity, magnetic fields, and stress and magnetisation of nickel and cobalt, are promised from the physical laboratory of the University of Glasgow by Prof. Gray, his assistants and the research students in his department. Dr. Larmor will give a paper on radiation, Dr. Hicks a paper on the Michelson-Morley effect and Dr. Glazebrook a paper on optical glass. In the meteorological department, Mr. W. N. Shaw and one of his assistants will give two papers treating of the seasonal variations of air temperature.

Section B (Chemistry).—The following papers have already been promised:—On the transitional forms between crystalloids and colloids, by Messrs. J. H. Gladstone and W. Hibbert; the oxidation of tin, including the action of light, by Messrs. J. H. Gladstone and G. Gladstone. Papers on the following subjects will also be submitted:—On the deposition of ocean salts, on electrochemical processes and on the manufacture of cyanides.

Section C (Geology).—Papers to this section are promised by Messrs. William Gunn, B. N. Peach, R. H. Traquair, Robert Kidston and H. B. Woodward. Several others have intimated a wish to read short papers on subjects in which they are specially interested.

Section G (Engineering).—A paper on the mechanical exhibits at the Glasgow International Exhibition is being arranged for. After a report on road traction is submitted by a committee appointed for the purpose, papers bearing on this subject will be read by Messrs. A. R. Sennett, A. H. Gibbings and Sir J. H. A. Macdonald. The following papers will also be given to this section:—Protection of buildings from lightning, by Mr. K. Hedges; dielectric hysteresis, by Mr. W. M. Mordey; Panama Canal, by Mr. M. Buon Varilla; tunnelling in quicksand, by Mr. M. A. Gobert; chain driving, by Mr. C. Garran; engraving machinery, by Mr. M. Barr; and aluminium as a fuel, by Sir W. C. Roberts-Austen. Mr. Barr will probably show his apparatus working in the municipal buildings during the evening of Thursday, September 12.

Section K (Botany).—There will be a discussion in this section on the teaching of botany, opened by Mr. Wager from the standpoint of botany teaching in schools, and by Prof. Bower from the point of view of University teaching. Profs. Ward, Scott-Elliott, Miall and others will take part in the discussion. It is intended to ask members of Section L, the educational section, to take a share in the discussion. Prof. Reynolds Green will probably give a semi-popular lecture on a botanical subject of general interest.

Section L (Educational Science).—After the president, Sir John E. Gorst, delivers his presidential address, it is expected there will be a discussion on Scottish educational systems. This discussion will probably be introduced by two papers, one by Mr. John Adams, on mechanism of education in Scotland, and the second by Dr. J. G. Kerr, on the training of the practical person.

On account of the International Exhibition there is a great influx of visitors to Glasgow, and members of the British Association who intend to be present at the Glasgow meeting are strongly recommended to make early arrangements for their rooms. The local committee have prepared a list of hotels and a preliminary list of lodgings and apartments. This list is ready to be sent to any inquirer. MAGNUS MACLEAN.

NOTES.

PROF. A. W. RÜCKER, professor of physics at the Royal College of Science and secretary of the Royal Society, has been appointed principal of the University of London. We are informed that, in consequence of his appointment to this post, Prof. Rücker will resign the secretaryship of the Royal Society at the next anniversary meeting.

PROF. VIRCHOW'S eightieth birthday will be celebrated in Berlin on Saturday, October 12, when he will personally receive delegates with congratulatory addresses from various scientific bodies, foreign as well as German. Prof. Waldeyer is the president of the executive committee.

THE Council of the Royal Society has awarded the Mackinnon studentship to Mr. J. J. R. Macleod, demonstrator of physiology in the London Hospital Medical College, for the purpose of enabling him to carry out researches in pathological chemistry. The studentship is founded under a bequest to the Royal Society by the late Sir William Mackinnon, Director-General of the Medical Department of the Army, for the foundation and endowment of prizes or scholarships for the special purpose of furthering natural and physical science, and of furthering original research and investigation in pathology. The studentship, for which fourteen applications were received, is of the annual value of 150*l*.

THE death is announced of Mr. J. Hamblin Smith, the well-known mathematical coach at Cambridge and author of numerous successful text-books of elementary mathematics. Mr. Smith was seventy-four years of age.

PROF. PASQUALE VILLARI has been elected president of the Reale Accademia dei Lincei, of Rome, in succession to the late Prof. Messedaglia.

AN excursion to the Auvergne district has been arranged by the Geologists' Association. The party will leave London on the evening of Thursday, August 15, and will journey to Clermont, which will be the centre of the excursions. The visit will last a fortnight, and an excellent programme has been arranged under the direction of Prof. Marcellin Boule, Prof. P. Glangeaud and M. J. Giraud.

A TELEGRAM from Ponta Delgada to the *Times* states that the International Meteorological Observatory in the Azores was inaugurated on July 10 by the King of Portugal. The Portuguese Prime Minister, the Minister of Marine, the civil governor of the islands and the different authorities, together with a number of Portuguese officers and the officers of the British cruisers *Australia* and *Severn*, were present at the ceremony.

WE are sorry to learn that the biological station which had been kept on Lake Baikal for a year by the East Siberian Geographical Society, at Goloustnaya, on the west coast, has been closed. A rich collection of fishes, especially of Cottus species, and a great variety of Gammarus species have, however, been secured, and the latter are in the hands of Prof. Sars, of Christiania.

ON Tuesday, July 16, a deputation of members of Parliament and engineering and shipbuilding societies waited upon Lord

Selborne (First Lord of the Admiralty) and Mr. Arnold-Forster (Parliamentary Secretary to the Admiralty), at Whitehall, to urge the necessity of improving the conditions of the service of engineers in the Royal Navy. Lord Selborne promised that the suggestions of the deputation would be carefully considered.

THE French Société d'Encouragement pour l'Industrie nationale announces the following awards of prizes:—Grand gold medal to the Chamber of Commerce of Lyons for the organisation of the commercial mission to China; 2000 francs to M. Horsin-Déon for his work on beetroot sugar; 500 francs to M. R. Fosse for his works on β-dinaphthol, and the same amount to M. Marcel Guichard for his works on molybdenum; 1000 francs to M. Triboudeau for his study of the Pas-de-Calais, and 1000 each to MM. Faure and Thénard for memoirs on the utilisation of waters in agriculture.

A REUTER telegram from St. Petersburg, dated July 11, says:—The St. Petersburg Academy of Sciences to-day received a telegram from the leader of the expedition which is shortly to bring to St. Petersburg the mammoth found in Siberia. The telegram, which is despatched from Yakutsk, reports that the expedition arrived at that place on June 14. It is proceeding by steamer up the river, and will then journey overland to Kolymsk, which is 3000 versts off, and where it expects to arrive in two-and-a-half months. The mammoth found is unique of its kind. Its hair, skin and flesh are entirely preserved, and there are remains of undigested food in its stomach.

AN interesting relic is reported by the *Times* to have been placed in the building of the Academy of Sciences at Tsarskoe-Selo. It is a large geographical globe, 11 ft. in diameter and made of copper. This globe was commenced in the year 1654 and completed ten years later during the reign of Duke Frederick of Holstein. The outside represents the earth, and the interior the celestial spheres of the world. There is a door giving access to the interior of this globe, and in the centre is a round table with space for twelve people to sit. By means of mechanism this great globe can be made to revolve upon its axis. The globe weighs about 3½ tons and was presented to the Academy of Sciences in 1725, but until now it has stood in the Zoological Museum at Tsarskoe-Selo.

THE executive committee of the National Physical Laboratory have made the following appointments:—Superintendent of the engineering department, Dr. T. E. Stanton; assistants in the physics department, Dr. J. A. Harker, Mr. A. Campbell and Dr. H. C. H. Carpenter; junior assistants, Mr. B. F. E. Keeling and Mr. F. E. Smith. It is expected that one or two more junior assistants will be appointed shortly. The alterations to Bushy House and the new buildings for the engineering laboratory are well advanced, and it is hoped to commence work early in October. Of the staff, Dr. Stanton, after serving an apprenticeship with an engineering firm in the Midlands, has had a distinguished career at Manchester and Liverpool, and is now professor of engineering at University College, Bristol. Dr. Harker and Mr. Campbell have both done work of real value in thermometry and electric measurements, while Dr. Carpenter, who will have charge of the chemical researches, after a successful course at Oxford has gained further experience at Leipzig, under Ostwald, and more recently at Owens College. Mr. Keeling obtained a double first in natural science and mechanical science, respectively, at Cambridge, while Mr. Smith was the most distinguished student of his year at South Kensington, and for two years has been one of Prof. Rücker's assistants.

THE programme has been issued of the meeting of the Iron and Steel Institute, to be held in Glasgow on September 3-6 in connection with Section V. of the International Engineering Congress. The remaining eight sections of the Congress will be under the charge of other institutions. The meetings will be held in the University buildings, which are in immediate proximity to the International Exhibition. The president will deliver a short address, and the following are among the subjects of papers:—The nomenclature of metallography; the presence of calcium in high-grade ferro-silicon; the spectra of flames at different periods during the basic Bessemer blow; iron and copper alloys; the correct treatment of steel; the profitable utilisation of power from blast-furnace gas; Brinell's method of determining hardness and other properties of iron and steel; internal strains in iron and their bearing upon fracture; and a mechanical gas producer.

A SATISFACTORY trial of a new airship, devised by M. Santos Dumont, took place at Paris early on Saturday morning. It may be remembered that M. Henry Deutsch has offered a prize of 100,000 francs (4000*l.*) to the inventor of a flying machine which would travel from the heights of Saint Cloud to and round the Eiffel Tower and back again to the starting point in half an hour. M. Santos Dumont did the journey in forty-one minutes on Saturday, that is to say he made a voyage of nearly ten miles at a speed of about fifteen miles an hour, though the return journey was against the wind. He did not win the prize, but his attempt is very encouraging, for he has shown that an airship can be made to travel at a high speed in any direction. His airship consists of a cigar-shaped balloon, six metres in diameter, thirty-four metres long, and having a volume of 550 cubic metres. The gas pressure is kept constant automatically by means of a ventilator driven by the engine and communicating with the balloon by means of a long canvas pipe. Suspended from the balloon is a light framework containing a petroleum motor of 16 horse-power, driving shaft, propeller and rudder, and near one end is a small wickerwork car in which the aëronaut stands and controls the steering-wheel and the apparatus for regulating the motor. M. Deutsch is constructing a similar balloon to that of M. Santos Dumont, but having a volume of 2000 cubic metres and a motor of sixty horse-power. M. Santos Dumont proposes to make another trial trip next Saturday. When going at full speed the propeller makes 200 revolutions per minute.

THE annual report of the Russian Geographical Society for 1900, which has only recently reached us, is, as usual, full of interest. It is especially interesting to notice the growing activity of the young branches of the Society at Vladivostok, Kiakhta, Tomsk and Orenburg—their work being not limited to pure geography, but being mainly directed to the exploration of the geology, botany, zoology and prehistoric anthropology of the respective regions. A new local museum has consequently been opened at Troitskosavsk, near Kiakhta, in addition to those of Minusinsk and Yeniseisk. The chief medal of the Geographical Society, the Constantine medal, was awarded this year to V. Obrucheff, the explorer of the Nan-shan and Mongolia, who has also explored very large portions of Transbaikalia and the Pacific littoral, and whose preliminary reports are always of the deepest interest for both the geologist and the orographer. The Count Lütke medal was awarded to M. E. Zhdanko for his extensive geodetical and hydrographical works in the far North, the Semenoff medal to J. A. Kersnovsky for work in meteorology, and the Prjevalski medal to the Tomsk professor, V. V. Sapozhnikoff, whose explorations of the Altai highlands revealed hundreds of unknown glaciers, as well as widely-spread traces of glaciation, and threw much new light on the geography of the whole region. These researches are now embodied in a work, "The Katuñ and its Sources" (with maps and a summary in French).

THE arrangements made for the meetings of the fifth International Congress of Zoology, to be held in Berlin on August

12-16, were described at the beginning of this year (January 3, p. 236), when the invitation circular was distributed. We are now informed that 114 papers have been proposed by zoologists of various nationalities, so that the Congress promises to be of real scientific importance. The magnificent rooms of the German House of Parliament have been put at the disposal of the Congress, and, with the exception of a few lectures to be delivered in the Chemical Institute of the University, all the meetings will be held in the Reichstag building. The sections of the Congress will be: I. General zoology; II. Vertebrata (biology, classification, distribution); III. Vertebrata (anatomy, histology, embryology); IV. Evertebrata except Arthropods; V. Arthropoda; VI. Economic zoology (fisheries, &c.); VII. Nomenclature. Zoologists who wish to read papers should send abstracts not exceeding fifteen lines of print to the Præsidium of the Congress not later than August 1. The complete papers must be sent in not later than October 1. The Congress will be opened at the Reichstagsbäude on Sunday, August 11, at 8 p.m. The subjects of lectures to be delivered in the course of the meeting are: the malarial problem from a zoological point of view, by Prof. G. B. Grassi; vitalism and mechanism, by Prof. Bütschli; theories of fertilisation, by Prof. Yves Délage; the psychological attributes of ants, by Prof. Forel; mimicry and natural selection, by Prof. E. B. Poulton; fossil remains of man, by Prof. Branco. Letters and applications for tickets should be addressed to the Präsidium des V. Internationalen Zoologen-Congresses, Berlin N. 4, Invalidenstrasse 43.

THE new pathological institute connected with the London Hospital Medical College was opened by Sir Henry Roscoe on July 10. The building has cost 20,000*l.*, the fitting-up will need another 1000*l.* and the carrying on of the department will cost about 1200*l.* a year. The director of the institute is Dr. Bullock. Mr. Sydney Holland, who occupied the chair at the opening ceremony, remarked that in the new laboratories studies of the causes of disease could be made under conditions which made success possible and advance probable. There would be an orderly continuity of observation which had hitherto been impossible and which would be carried on by men who were specially trained in that science and who loved it for its own sake and for its benefit to their fellow men. This was work by which the whole country would benefit, and yet they got no help from the Government. Scotch hospitals and Irish hospitals obtained grants from the Government, but English hospitals got none and were cramped in every direction for funds. Every German town, even small ones, had its pathological laboratories. The County Council had established one at Claybury, but the one they were opening was the first attempt in London to deal so completely with this most important branch of medical knowledge. In opening the building, Sir Henry Roscoe remarked that it was unique among the large hospitals of London. It was the most completely equipped department for dealing with pathology in a manner worthy of the importance of that branch of medical science. For it was now generally acknowledged that pathology was an essential portion of those studies which made up the great science of medicine. It was necessary to have a centre where pathology was studied for its own sake and not for purposes of immediate practical application, still less for mere examinational purposes. The institute would form, he trusted, an introductory stage for entrance to that still higher and more advanced school of research which had its home in he Jenner Institute at Chelsea.

AN unfortunate controversy having arisen on the question of priority in the proof of the mosquito theory of the transference of malarial infection, Major Ronald Ross has published some correspondence on the subject which shows that the claims of some of the Italian observers cannot be substantiated ("Letters from Rome on the New Discoveries in Malaria," 1900). These eight letters were written by Dr. Edmonston Charles, a resident in Rome, to Major Ross, then in India, and date from November 4, 1898, to January 14, 1899; a letter from Dr. Daniels is included, and they are preceded by a critical introduction, and terminate with a postscript and bibliography by Ross. At this period the Italians, notably Grassi, Bignami and Bastianelli, were endeavouring to follow Ross's investigations on the development of the malarial parasites in the mosquito, and Dr. Charles acted as an intermediary, informing Ross of the progress made by the Italians, and similarly communicating to the latter Ross's observations and handing them his specimens. In the first letter, Charles asks for specimens for Marchiafava "of the mosquito in which human malaria develops." Grassi now denies that Ross ever detected this species. It is pointed out how closely the Italians followed and how well informed they were of the details of Ross's work, yet now Grassi states that his labours were independent of Ross. In the third letter, with regard to the cultivation of crescents in the "dappled winged mosquito" by Ross, Charles says, "he (Grassi) seemed perfectly satisfied that your description referred to the *Anopheles claviger*." Grassi now contends that he could not identify the malaria-bearing mosquito from Ross's description. Bignami, Grassi and Bastianelli have frequently stated that Ross's first successful experiments with human malaria were unsound, because the insects employed might have already bitten another animal before having been fed on man. Yet in Ross's publication it is clearly premised that the insects had been bred in bottles from the larvæ. These and other claims are dealt with in this publication.

THE art of producing decorative illuminating effects by the use of electric light is one that has in recent years called forth the application of great engineering skill. Particular attention has been given to this point at the Pan-American exhibition now being held at Buffalo, and those who are fortunate enough to visit this exhibition will be able to admire what is probably the most comprehensive and carefully studied system of illumination that has as yet been carried out. The less fortunate can obtain some idea of the great beauty of some of the effects from the very excellent photographs that have been recently appearing in the *Electrical Review* of New York. Those responsible for the illumination at Buffalo were to a certain extent favoured by circumstances in that they had a cheap supply of electricity available from the neighbouring power station at Niagara. It was thus possible, not only to get current cheaply, but also to control the lighting of the whole exhibition from one centre. Power is transmitted from Niagara, 20 miles distant, at a pressure of 11,000 volts, and after undergoing a transformation down to an intermediate voltage of 1800 is again transformed down to the voltage for supplying the lamps. An additional effect is produced by gradually bringing up the lamps from darkness to full candle power instead of switching on the full light instantaneously. To carry this out the whole of the current used for illuminating the buildings is passed through three large water rheostats, consisting of iron tanks 10 feet long by 3 feet wide and 3 feet deep, into which cast-iron plates, 8 feet long by $\frac{3}{4}$ inch thick, are slowly lowered; when the plate reaches the bottom of the tank it strikes a clip which short circuits the rheostat. The three rheostats are worked simultaneously, the plates being lowered and raised by a small electric motor; 45 seconds is taken to light up the lamps, which are put out in a somewhat longer period of about 75 seconds.

THE director of the Belgian Meteorological Service has recently published a very useful memoir on the direction of the wind at Brussels, compiled from fifty years' observations (1842-1891). The work forms the third part of the series, those referring to barometric pressure and air temperature having already appeared. The wind-directions are grouped in various ways; among the tables we find the relative frequency arranged under sixteen points of the compass, for each month and for each season, during the fifty separate years deduced from the hourly or two-hourly indications of a self-recording anemometer. The plates containing the average monthly and yearly wind-roses show the prevailing directions more clearly than anything else could do. It is seen at a glance that the winds between south-west and west are more frequent than all the other directions combined.

SIGNOR G. ODDO, writing in the *Atti dei Lincei* on the use of oxychloride of phosphorus as a solvent in cryoscopic observations, finds that the cryoscopic constant of this solvent is 69, and that, like water, but within narrower limits, it ionises dilute saline solutions.

THE stability of a given state of motion is a subject on which much has been written and more remains to be written. A paper on certain criteria of instability, by Signor T. Levi-Cività, appears in the *Annali di matematica pura ed applicata*. After discussing the general theory, the author proceeds to consider the problem of three bodies, and shows in particular that periodical solutions approximating to uniform circular motions are unstable, a conclusion contrary to what would naturally be inferred from considerations of celestial mechanics. The same author, writing in the *Atti dei Lincei*, deals with the stationary motions of a rigid body in the case of Kowalevsky.

DR. F. CAUBET, of the University of Bordeaux, has published a lengthy thesis on the liquefaction of gaseous mixtures, dealing in particular with the phenomena of the critical point and of retrograde condensation. In it the author describes an elaborate series of experimental determinations of the isothermal lines, the lines of Gibbs and Konowaloff, and the dew- and boiling-points of three series of mixtures each formed of two of the three gases, methyl chloride, carbonic anhydride and sulphurous anhydride. By tracing the isothermals for different degrees of concentration, both in the homogeneous and in the heterogeneous states, Dr. Caubet hopes to throw experimental light on the theories derived from considerations of the thermodynamic potential.

AN account of the earthquake of April 24, in the neighbourhood of Palombara Sabina, is given by Dr. Luigi Palazzo in the *Atti dei Lincei*, x. 9. The shock was registered at the Central Meteorological Office at about 15h. 20m. 25s. Italian time, and lasted about five to six seconds. The town of Palombara was visited without delay by Prof. Cancani, who found that the damage in the centre of the town was small; but in the village of Stazzano four or five houses were destroyed, others rendered uninhabitable, while considerable damage was done at Cretone, and the author thinks it probable that the epicentre was at a sulphur spring about a kilometre distant from Cretone, and that the origin of the shock was in the strata from which the spring arises, at a comparatively small depth.

THE current number of the *Journal of Hygiene* contains, amongst other articles, an appreciative obituary notice of Prof. Max von Pettenkofer, accompanied by an excellent portrait. Pettenkofer's name is now so invariably associated with investigations in the department of hygiene that his earlier work in pure chemistry runs a risk of being overlooked. As long ago as 1850 he presented to the Bavarian Academy a paper calling attention to some of the main facts which form the basis of the periodic law of the elements, but, like Newlands in this country, his work obtained no recognition at the time, and it was only in 1899 that the German Chemical Society conferred upon him the Liebig medal in tardy recognition of the merit of his researches of nearly half a century before. It was largely due to Pettenkofer that Germany has now chairs of hygiene with magnificent laboratories in all but one of her twenty universities, besides the famous Imperial Institute of Public Health in Berlin.

IN their Report for the past year the council of the Leicester Literary and Philosophical Society announce that they are cooperating with the National Trust for the Preservation of Objects of Historical Interest or Natural Beauty, and that steps are being taken to register and protect such objects in the county as may come within the scope of the Society's aims. The *Transactions* (issued with the Report) contain a lecture on heredity and the question of the inheritance of acquired characters, by Mr. C. J. Bond. Dr. J. G. Adams, professor of pathology at McGill University, sends us a reprint from the *New York Medical Journal* for June of an address on the same subject, in which he proposes to supersede Weismann's and allied theories on heredity and inheritance by one of his own.

AN article on the fauna of the Antarctic ("La Faune du pôle-Sud"), contributed by M. E. G. Racovitza to the *Revue Scientifique* for July 6, appears opportunely. It is based on the results of the recent Belgian expedition and contains a general account of the fauna, with special details of the habits of the penguins, and a few notes on the flora. Since the whole of the Antarctic land (both continent and islands) appears to be invested with an unbroken sheet of inland ice (miscalled *inlandsis*), the author does not hold out hopes of the discovery of any important new types of life in the interior.

TO the January issue of the *Journal* of the Straits branch of the Royal Asiatic Society, Mr. H. N. Ridley, director of the Botanical Gardens at Singapore, communicates an extremely interesting paper on the flora of Mount Ophir. This flora includes three factors, a lowland Malay element, specially modified for existence at a higher elevation, the usual Oriental alpine (or Himalayan) element and—what is most interesting and unexpected—an Australian element. The same journal also contains a list of the butterflies of Mount Penrissen, Sarawak, and one of the reptiles of Borneo, both by Mr. R. Shelford, curator of the Sarawak Museum.

MR. L. M. LAMBE has published a revision of the genera and species of Canadian Palæozoic Corals ("Contributions to Canadian Palæontology," vol. iv. part ii. Geol. Survey Canada, 1901). His work is illustrated by thirteen plates.

IN a brief article on Indiana caves, Dr. O. C. Farrington discusses some peculiar forms of stalactites and stalagmites (*Publications* of the Field Columbian Museum, vol. i. No. 8, geol. series, 1901). The shape of certain vermiform stalactites is attributed, with Merrill, to the fact that drops of water may have been guided to other positions than those dictated by gravity by the directions assumed by spicules of calcite in crystallising. In one huge stalagmite both aragonite and calcite occur, and its minimum age is reckoned at 90,000 years. Lining the walls of a pool in one of the caves are calcite crystals in close association with stalagmites; here the crystals were formed in relatively still water, while the stalactites and stalagmites were formed when the water was moving. The author suggests that in a general way banded structures may be taken as indicating formation from waters in motion, while distinct crystals were formed from waters at rest; and he would apply these principles to the origin of mineral veins, agates, geodes, &c. He proposes the term stagmalites for formations produced by dropping water, and to include stalactites and stalagmites.

THE *Transactions* of the "Antonio Alzate" Society of Mexico contain a paper by MM. Marroquin y Rivera and P. C. Sánchez on the mountain chain of the Ajusco and its subterranean waters. In the northern part of the Vallée de Mexico, which is a closed basin, are two lakes named Chalco and

Xochimilco, containing excellent water, but their level is so low that it could only be made available for supplying the city of Mexico by enormous expenditure for pumping machinery. The basin of these lakes is bounded on the south and east by the mountains of the Ajusco and Sierra Nevada, and on the north by the Santa Catarina; a depression to the north-east connects it with the Vallée de Mexico, of which it forms a part. The lakes are fed by springs draining the underground waters from the volcanic formations of the Sierra Nevada and the Ajusco. The paper, which is an interesting study of the physical geography of the region, gives a preliminary account of attempts to tap these underground waters at a suitable level for gravitational supply to Mexico. The impermeable bed, believed to be andesitic, is being sought for below the basalt lavas and detritus by means of borings.

THE technique of basketry as manufactured by the Amerinds is the subject of a very valuable little paper by Dr. Otis T. Mason in the *American Anthropologist* (n.s., vol. iii. p. 109). Those who have desired to describe baskets and other objects plaited by primitive peoples have long wanted a system upon which to base their studies. This Dr. Mason has supplied, and all who study primitive industries once more have to thank their diligent and systematic American colleague.

THE *Kew Bulletin of Miscellaneous Information* (Appendix iii. 1901) contains the usual annual list of new garden plants recorded during last year in botanical and horticultural publications. The list includes, not only plants brought into cultivation for the first time during 1900, but the most noteworthy of those which have been re-introduced after being lost from cultivation.

A SECOND edition of "Marine Boiler Management and Construction," by Mr. C. E. Stromeyer, has been published by Messrs. Longmans, Green and Co. The book is described in the sub-title as "a treatise on boiler troubles and repairs, corrosion, fuels and heat, on the properties of iron and steel, on boiler mechanics, workshop practices and boiler design"; it was reviewed in these columns when the first edition appeared (vol. xlix. p. 410). About sixty pages of new matter have been added, including a chapter on steam, water and the boiling phenomena. No detailed accounts are given concerning water-tube boilers, because little exact information about the various types is available.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Mr. E. Robinson; a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Mr. L. Gough; a Northern Mocking-bird (*Mimus polyglottis*) from North America, a Common Chameleon (*Chamaeleon vulgaris*) from North Africa, a Green Lizard (*Lacerta viridis*), European, presented by Miss Betty Cox; two Chaplain Crows (*Corvus capellanus*) from the Persian Gulf, presented by Mr. B. T. Ffinch; two Olive Weaver-birds (*Hyphantornis capensis*), two Alario Sparrows (*Passer alario*), eight Sulphury Seed-eaters (*Crithagra sulphurata*) from South Africa, presented by Mrs. R. Templeman; a Jackdaw (*Corvus monedula*), British, presented by Mr. L. Peevor; a Green Monkey (*Cercopithecus callitrichus*), a Jardine's Parrot (*Paeocephalus gulielmi*) from West Africa, a Pine Marten (*Mustela martes*), British; three King Snakes (*Coronella getula*), two Mexican Snakes (*Coluber melanoleucus*), a Chained Snake (*Coluber catenifer*), two Corn Snakes (*Coluber guttatus*), two Chicken Snakes (*Coluber obsoletus*), three Testaceous Snakes (*Zamenis flagelliformis*), a Long-nosed Snake (*Heterodon nasica*), an Amphiuma (*Amphiuma means*), three Menopomas (*Cryptobranchus alleghaniensis*), two Menobranchs (*Necturus maculatus*) from North America, deposited; two Barbary Wild Sheep (*Ovis tragelaphus*), a Japanese Deer (*Cervus sika*), a Yak (*Poephagus grunniens*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

WAVE-LENGTH OF GREEN CORONA LINE.—In the *Mem. della Soc. Degli. Spett. Ital.* (vol. xxx. pp. 124–128), Sig. Ascarza describes the results of observations made at Plascencia by the party from the Madrid Observatory during the total eclipse of the sun on May 27, 1900.

The instrumental equipment consisted of a Grubb coelostat with a mirror 20 centimetres diameter, furnishing light for a Steinheil objective of 12 centimetres aperture and 1·80 metres focus. This produced on the slit of the spectroscope an image of the sun about 16 millimetres in diameter.

A Dubosq spectroscope was used, furnished with six prisms and eyepiece micrometer reading to 1 : 300th of a millimetre. On account of the absorption of the prisms, only *three* were used for the final observations.

For the determination, measures were made on the lines 5328·696, 5270, 108 (E), and 5183·792 (b_1), and the resulting measures of the corona line reduced by interpolation formulæ. The spectroscope not being sufficiently powerful to separate the components of E, the mean of the wave-lengths of the two was adopted.

Preparation was made for both radial and tangential measures, but on account of the diffuse character of the line the tangential method was applied. The results were reduced by two interpolation formulæ, Gibbs and Hartmann, slightly varying values being obtained. The wave-lengths found on Rowland's scale were 5298·7 and 5298·818 respectively. The paper concludes with a note stating the difference of 4 tenth-metres between this value and that of 5303 obtained by Lockyer and Campbell from photographs taken during the total solar eclipse in India on January 22, 1898.

DEFORMATION OF THE SUN'S DISC.—In the *Mem. della Soc. Degli. Spett. Ital.* (vol. xxx. pp. 96–110), Sig. A. Ricco describes a long series of observations, both visual and photographic, of the varying deformations of the disc of the sun by the effect of atmospheric refraction, made at the observatories of Palermo and Catania (Etna). Many of the visual observations were made with a small Ramsden telescope having a terrestrial eyepiece, magnifying five times; photographs were also taken with a Merz telescope of 0·115 metre aperture and 1·93 metres focal length, adjusted to the chemical focus, giving an image about 0·0175 metre diameter.

The paper is illustrated by drawings and reproductions from many of the photographs, which are similar in many respects to those obtained by Colton at the Lick Observatory and published about 1895.

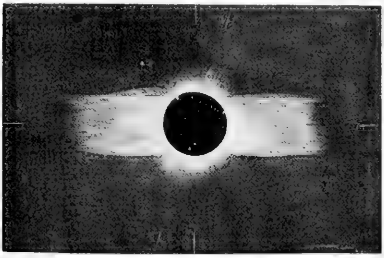
THE MINOR PLANET TERCIDINA.—In the note on p. 265, Prof. Hartmann's observations were misinterpreted. The photographs obtained at the Potsdam Observatory do not confirm the suspected variability suggested by the photograph obtained by Prof. Wolf in November 1899, nor do the later photographs of Prof. Wolf. The apparent variation may possibly be due to instrumental irregularities.

THE TOTAL ECLIPSE OF MAY 18, 1901.

THE following account of the total eclipse of the sun, May 18, is taken from a letter received from Mr. J. Cresswell, who was formerly a student of astronomical physics at the Royal College of Science, and is now engaged at a mining camp near the centre of Borneo (lat. 0° 45′ S., long. 113° E.).

The eclipse commenced about 12.20 in a cloudy sky, but fortunately about 15 minutes before totality the whole sky cleared and revealed a crescent sun. There were only one or two small clouds near the horizon, and the landscape appeared to have a peculiar violet tinge. There was no fall in temperature up to this point, the thermometer having remained stationary at 34°·75 C. Four minutes afterwards the landscape appeared as if seen through smoked glass, the temperature now being 34°·5. After the lapse of another 8 minutes the light was like that when a heavy storm is gathering, and shadows had a peculiar transparency; a number of stars appeared in the heavens distant from the sun. After 2½ minutes more had elapsed, second contact occurred and we were in darkness. The accompanying sketch of the corona was made and a photograph was taken with a small camera. The darkness was such that a small paraffin candle burning 100 metres away appeared quite bright. After about a minute the bright prominence *a* was seen, and it seemed to penetrate slightly into the dark body of the moon; this was seen for quite two minutes. Just before third contact the blood-red chromosphere appeared. At this time the temperature had steadily fallen to 31° C., but the lowest temperature recorded was 30°·25, at 2h. 6m. 30s., making a total fall in temperature of 4°·5 C.

Through a ruby glass the corona was invisible, except an irregular rim about one-eighth of the sun's diameter in width.



No air movements were noticed during the eclipse. Birds were not noticed to go to roost, but it was stated that some fowls did so. There is an insect known to the Dyaks as the "six o'clock insect," which invariably gives utterance to a very loud horn-like cry just before dark (*i.e.* about 6 p.m.), but its call was not heard during the eclipse.

THE AIMS OF THE NATIONAL PHYSICAL LABORATORY.[1]

THE idea of a physical laboratory in which problems bearing at once on science and on industry might be solved is comparatively new. The Physikalisch-Technische Reichsanstalt, founded in Berlin by the joint labours of Werner von Siemens and von Helmholtz during the years 1883–87, was perhaps the first. It is less than ten years since Dr. Lodge, in his address to Section A of the British Association, outlined the scheme of work for such an institution here in England. Nothing came of this; a committee met and discussed plans, but it was felt to be hopeless to approach the Government, and without Government aid there were no funds.

Four years later, however, the late Sir Douglas Galton took the matter up. In his address to the British Association in 1895, and again in a paper read before Section A, he called attention to the work done for Germany by the Reichsanstalt and to the crying need for a similar institution in England.

The result of this presidential pronouncement was the formation of a committee which reported at Liverpool, giving a rough outline of a possible scheme of organisation. A petition to Lord Salisbury followed, and as a consequence a Treasury committee, with Lord Rayleigh in the chair, was appointed to consider the desirability of establishing a National Physical Laboratory. The committee examined more than thirty witnesses and then reported unanimously "that a public institution should be founded for standardising and verifying instruments for testing materials and for the determination of physical constants."

It is natural to turn to the words of those who were instrumental in securing the appointment of this committee, and to the evidence it received, in any endeavour to discuss its aim. As was fitting, Sir Douglas Galton was the first witness to be called. It is a source of sorrow to his many friends that he has not lived to see the Laboratory completed.

And here may I refer to another serious loss which, in the last few days, the Laboratory has sustained. Sir Courtenay Boyle was a member of Lord Rayleigh's committee, and as such was convinced of the need for the Laboratory and of the importance of the work it could do. He took an active part in its organisation, sparing neither time nor trouble; he intended that it should be a great institution, and he had the will and the power to help. The country is the poorer by his sudden death.

Let me now quote some of Sir Douglas Galton's evidence. "Formerly our progress in machinery," he says, "was due to accuracy of measurement, and that was a class of work which could be done, as Whitworth showed, by an educated eye and educated touch. But as we advance in the applications of science to industry we require accuracy to be carried into matters which cannot be so measured. . . . In the more delicate researches which the physical, chemical and electrical student undertakes, he requires a ready means of access to standards to enable him to compare his own work with that of others." Or again, "My view is that if Great Britain is to retain its industrial supremacy we must have accurate standards available to our research students and to our manufacturers. I am certain that if you had them our manufacturers would gradually become very much more qualified for advancing our manufacturing industry than they are now. But it is also certain that you cannot separate some research from a standardising department." Then, after a description of the Reichsanstalt, he continues, "What I would advocate would be an extension of Kew in the direction of the second division of the Reichsanstalt, with such auxiliary research in the establishment itself as may be found necessary." The second division is the one which takes charge of technical and industrial questions. Prof. Lodge, again, gave a very valuable summary of work which ought to be done.

It is now realised, at any rate by the more enlightened of our leaders of industry, that science can help them. This fact, however, has been grasped by too few in England; our rivals in Germany and America know it well, and the first aim of the Laboratory is to bring its truth home to all, to assist in promoting a union which is certainly necessary if England is to retain her supremacy in trade and in manufacture, to make the forces of science available for the nation, to break down by every possible means the barrier between theory and practice, and to point out plainly the plan which must be followed unless we are prepared to see our rivals take our place.

"Germany," an American writer who has recently made a study of the subject has said, "is rapidly moving towards industrial supremacy in Europe. One of the most potent factors in this notable advance is the perfected alliance between science and commerce existing in Germany. Science has come to be regarded there as a commercial factor. If England is losing her supremacy in manufactures and in commerce, as many claim, it is because of English conservatism and the failure to utilise to the fullest extent the lessons taught by science, while Germany, once the country of dreamers and theorists, has now become intensely practical. Science there no longer seeks court and cloister, but is in open alliance with commerce and industry." It is our aim to promote this alliance in England, and for this purpose the National Physical Laboratory has been founded.

It is hardly necessary to quote chapter and verse for the assertion that the close connection between science and industry has had a predominant effect on German trade. If authority is wanted, I would refer to the history of the anilin dye manufacture, or, to take a more recent case, to the artificial indigo industry, in which the success of the Badische Company has recently been so marked. The factory at Ludwigshaven started thirty-five years ago with 30 men; it now employs more than 6000 and has on its staff 148 trained scientific chemists. And now, when it is perhaps too late, the Indian planters are calling in scientific aid and the Indian Government are giving some 3500*l.* a year to investigation.

As Prof. Armstrong, in a recent letter to the *Times*, says, "The truly serious side of the matter, however, is not the prospective loss of the entire indigo industry so much as the fact that an achievement such as that of the Badische Company seems past praying for here." Another instance is to be found in the German exhibit of scientific instruments at the Paris Exhibition, of which a full account appeared in the pages of NATURE.

And now, having stated in general terms the aims of the Laboratory and given some account of the progress in Germany, let me pass to some description of the means which have been placed at our disposal to realise those aims. I then wish, if time permits, to discuss in fuller detail some of the work which it is hoped we may take up immediately.

The Laboratory is to be at Bushy House, Teddington. I will

[1] A discourse delivered at the Royal Institution on Friday, May 24, by Dr. R. T. Glazebrook, F.R.S., Director of the Laboratory.

pass over the events which led to the change of site from the Old Deer Park at Richmond to Bushy. It is sufficient to say that at present Kew Observatory in the Deer Park will remain as the Observatory department of the Laboratory, and that most of the important verification and standardisation work which in the past has been done there will still find its home in the old building.

Bushy House was originally the official residence of the Ranger of Bushy Park. Queen Anne granted it in 1710 to the first Lord Halifax. In 1771 it passed to Lord North, being then probably rebuilt. Upon the death of Lord North's widow in 1797, the Duke of Clarence, afterwards William IV., became Ranger; after his death in 1837 it was granted to his widow, Queen Adelaide, who lived there until 1849. At her death it passed to the Duc de Nemours, son of King Louis Philippe, and he resided there at intervals until 1896.

In spite of this somewhat aristocratic history, it will make an admirable Laboratory. A description of the Laboratory, with illustrations, will be found in NATURE, vol. lxiii. p. 300.

The floor space available is much less than that of the Reichsanstalt. But size alone is not an unmixed advantage; there is much to be said in favour of gradual growth and development, provided the conditions are such as to favour growth. Personally I should prefer to begin in a small way if only I felt sure I was in a position to do the work thoroughly, but there is danger of starvation. Even with all the help we get in freedom from rent and taxes, outside repairs and maintenance, the sum at the disposal of the committee is too small.

Science is not yet regarded as a commercial factor in England. Is there no one who realises the importance of the alliance, who will come forward with more ample funds to start us on our course with a fair prospect of success? One candid friend has recently told us in print that the new institution is on such a microscopic scale that its utility in the present struggle is more than doubtful. Is there no statesman who can grasp the position and see that with, say, double the income the chances of our doing a great work would be increased a hundredfold?

The problems we have to solve are hard enough; give us means to employ the best men and we will answer them, starve us and then quote our failure as showing the uselessness of science applied to industry.

There is some justice in the criticism of one of our technical papers. I have recently been advertising for assistants, and a paper in whose columns the advertisement appears writes, "The scale of pay is certainly not extravagant. It is, however, possible that the duties will be correspondingly light."

Now let me illustrate these aims by a more detailed account of some of the problems of industry which have been solved by the application of science, and then of some others which remain unsolved and which the Laboratory hopes to attack. The story of the Jena Glass Works is most interesting; I will take it first.

An exhibition of scientific apparatus took place in London in 1876. Among the visitors to this was Prof. Abbé, of Jena, and in a report he wrote on the optical apparatus he called attention to the need for progress in the art of glass making if the microscope were to advance, and to the necessity for obtaining glasses having a different relation between dispersion and refractive index than that found in the material at the disposal of opticians. Stokes and Harcourt had already made attempts in this direction, but with no marked success.

In 1881 Abbé and Schott, at Jena, started their work. Their undertaking, they write five years later in the first catalogue of their factory, arose out of a scientific investigation into the connection between the optical properties of solid amorphous fluxes and their chemical constitution. When they began their work some six elements only entered into the composition of glass. By 1888 it had been found possible to combine with these, in quantities up to about 10 per cent., twenty-eight different elements, and the effect of each of these on the refractive index and dispersion had been measured. Thus, for example, the investigators found that by the addition of boron the ratio of the length of the blue end of the spectrum to that of the red was increased; the addition of fluorine potassium or sodium produced the opposite result.

Now in an ordinary achromatic lens of crown and flint, if the total dispersion for the two be the same, then for the flint glass the dispersion of the blue end is greater, that of the red less than for the crown; thus the image is not white, a secondary spectrum is the result.

Abbé showed, as Stokes and Harcourt had shown earlier, that by combining a large proportion of boron with the flint its dispersion was made more nearly the same as that of the crown, while by replacing the silicates in the crown glass by phosphates a still better result was obtained, and by the use of three glasses three lines of the spectrum could be combined; the spectrum outstanding was a tertiary one, and much less marked than that due to the original crown and flint glass. The modern microscope became possible.

The conditions to be satisfied in a photographic lens differ from those required for a microscope. Von Seidel had shown that with the ordinary flint and crown glasses the conditions for achromatism and for flatness of field cannot be simultaneously satisfied. To do this we need a glass of high refractive index and low dispersive power, or *vice versâ*; in ordinary glasses these two properties rise and fall together. By introducing barium into the crown glass a change is produced in this respect. For barium crown the refractive index is greater and the dispersive power less than for soft crown.

With two such glasses, then, the field can be achromatic and flat. The wonderful results obtained by Dallmeyer and Ross in this country, by Zeiss and Steinheil in Germany, are due to the use of these new glasses. They have also been applied with marked success to the manufacture of the object glasses of large telescopes.

But the Jena glasses have other uses besides optical. "About twenty years ago"—the quotation is from the catalogue of the German exhibition—"the manufacture of thermometers had come to a dead stop in Germany, thermometers being then invested with a defect, their liability to periodic changes, which seriously endangered German manufacture. Comprehensive investigations were then carried out by the Normal Aichungs Commission, the Reichanstalt and the Jena Glass Works, and much labour brought the desired reward."

The defect referred to was the temporary depression of the ice point which takes place in all thermometers after heating. Let the ice point of a thermometer be observed; then raise the thermometer to, say, 100°, and again observe the ice point as soon as possible afterwards; it will be depressed below its previous position. In some instruments of Thuringian glass a depression of as much as 0°·65 C. had been noted. For scientific purposes such an instrument is quite untrustworthy. If it be kept at, say, 15° and then immersed in a bath at 30°, its reading will be appreciably different from that which would be given if it were first raised to, say, 50°, allowed to cool quickly just below 30°, and then put into the bath. This was the defect which the investigators set themselves to cure.

Table I. gives some details as to thermometers.

TABLE I.

Depression of Freezing Point for various Thermometers.

Humboldt, 1835	0°·06
Greiner, 1872	0·38
Schultzer, 1875	0·44
Rapps, 1878	0·65
English glass	0·15
Verre Dur	0·08
16‴	0·05
59‴	0·02

Analysis of Glasses.

	SiO_2	Na_2O	CaO	Al_2O_3	ZnO	B_2O_3
16‴	67·5	14	7	2·5	7	2
59‴	72	11	—	5	—	12

Weber had found in 1883 that glasses which contain a mixture of soda and potash give a very large depression. He made a glass free from soda with a depression of 0°·1. The work was then taken up by the Aichungs Commission, the Reichsanstalt and the Jena factory. Weber's results were confirmed. An old thermometer of Humboldt's, containing 0·86 per cent. of soda and 20 per cent. of potash, had a depression of 0°·06, while a new instrument, in which the percentages were 12·7 per cent. and 10·6 per cent. respectively, had a depression of 0°·65.

An English standard, with 1·5 per cent. of soda and 12·3 per cent. of potash, gave a depression of 0°·15, while a French "verre dur" instrument, in which these proportions were reversed, gave only 0°·08.

It remained to manufacture a glass which should have a low depression and at the same time other satisfactory properties. The now well-known glass 16''' is the result. Its composition is shown in the Table.

The fact that there was an appreciable difference between the scale of the 16''' glass and that of the air thermometer led to further investigations, and another glass, a borosilicate containing 12 per cent. of boron, was the consequence. This glass has a still smaller depression.

Previous to 1888 Germany imported optical glass. At that date nearly all the glass required was of home manufacture. Very shortly afterwards an export trade in raw glass began, which in 1898 was worth 30,000*l.* per annum, while the value of optical instruments, such as telescopes, field-glasses and the like, exported that year was 250,000*l.* Such are the results of the application of science, *i.e.* organised common sense, to a great industry. The National Physical Laboratory aims at doing the like for England.

I have thus noted very briefly some of the ways in which science has become identified with trade in Germany, and have indicated some of the investigations by which the staff of the Reichsanstalt and others have advanced manufactures and commerce.

Let us turn now to the other side, to some of the problems which remain unsolved, to the work which our Laboratory is to do and by doing which it will realise the aims of its founders.

The microscopic examination of metals was begun by Sorby in 1864. Since that date many distinguished experimenters, Andrews, Arnold, Ewing, Martens, Osmond, Roberts-Austen, Stead and others, have added much to our knowledge. I am indebted to Sir W. Roberts-Austen for the slides which I am about to show you to illustrate some of the points arrived at. Prof. Ewing a year ago laid before the Royal Institution the results of the experiments of Mr. Rosenhain and himself.

This microscopic work has revealed to us the fact that steel must be regarded as a crystallised igneous rock. Moreover, it is capable, at temperatures far below its melting point, of altering its structure completely, and its mechanical and magnetic properties are intimately related to its structure. The chemical constitution of the steel may be unaltered, the amounts of carbon, silicon, manganese, &c., in the different forms remain the same, but the structure changes, and with it the properties of the steel.

Sections of the same steel polished and etched after various treatments show striking differences. For instance, if a highly carburised form containing 1·5 per cent. of carbon be cooled down from the liquid state, the temperature being read by the deflection of a galvanometer needle in circuit with a thermopile, the galvanometer shows a slowly falling temperature till we reach 1380° C., when solidification takes place; the changes which now go on take place in solid metal. After a time the temperature again falls until we reach 680°, when there is an evolution of heat; had the steel been free from carbon there would have been evolution of heat at 895° and again at 766°. Now throughout the cooling, molecular changes are going on in the steel. By quenching the steel suddenly at any given temperature we can check the change and examine microscopically the structure of the steel at the temperatu re at which it was checked.

[Slides were shown representing the microscopic structures of steels subjected to different treatment as regards temperature and annealing.]

These slides are sufficient to call attention to the changes which occur in solid iron, changes whose importance is now beginning to be realised. On viewing them it is a natural question to ask how all the other properties of iron related to its structure; can we by special treatment produce a steel more suited to the shipbuilder, the railway engineer or the dynamo maker than any he now possesses?

These marked effects are connected with variations in the condition of the carbon in the iron; can equally or possibly more marked changes be produced by the introduction of some other element? Guillaume's nickel steel, with its small coefficient of expansion, appears to have a future for many purposes; can it or some modification be made still more useful to the engineer?

We owe much to the investigations of the Alloys Research Committee of the Institution of Mechanical Engineers. Their distinguished chairman holds the view that the work of that committee has only begun, and that there is scope for such research for a long time to come at the National Physical Laboratory. The executive committee have accepted this view by naming as one of the first subjects to be investigated the connection between the magnetic quality and the physical, chemical and electrical properties of iron and its alloys, with a view specially to the determination of the conditions for low hysteresis and non-agency properties.

At any rate we may trust that the condition of affairs mentioned by Mr. Hadfield in his evidence before Lord Rayleigh's Commission which led a user of English steel to specify that before the steel could be accepted it must be stamped at the Reichsanstalt, will no longer exist.

The subject of wind pressure, again, is one which has occupied this committee's attention to some extent. The Board of Trade rules require that in bridges and similar structures (1) That a maximum pressure of 56 lbs. per square foot be provided for; (2) that the effective surface on which the wind acts should be assumed as from once to twice the area of the front surface, according to the extent of the openings in the lattice girders; (3) that a factor of safety of 4 for the iron work and of 2 for the whole bridge overturning be assumed. These recommendations were not based on any special experiments. The question had been investigated in part by the late Sir W. Siemens.

During the construction of the Forth Bridge Sir B. Baker conducted a series of observations. The results of the first two years' observations are shown in Table II., taken from a paper read at the British Association in 1884. Three gauges were used.

TABLE II.

Revolving gauge.		Small fixed gauge.		Large fixed gauge.	
Mean pressure.		Easterly.	Westerly.	Easterly.	Westerly.
lb.	lb.	lb.	lb.	lb.	lb.
0 to 5	3·09	3·47	2·92	2·04	1·9
5 to 10	7·58	4·8	7·7	3·54	4·75
10 to 15	12·4	6·27	13·2	4·55	8·26
15 to 20	17·06	7·4	17·9	5·5	12·66
20 to 25	21·0	12·25	22·75	8·6	19
25 to 30	27·0		28·5		18·25
30 to 35	32·5		38·5		21·5
Above	65		41·0		35·25
(One observation only above 32·5).					

In No. 1 the surface on which the wind acted was about $1\frac{1}{2}$ square feet in area; it was swivelled so as always to be at right angles to the wind. In No. 2 the area of surface acted on was of the same size, but it was fixed with its plane north and south. No. 3 was also fixed in the same direction, but it had 200 times the area, its surface being 300 square feet.

In preparing the table the mean of all the readings of the revolving gauge between 0 and 5, 5 and 10, &c., lbs. per square foot have been taken, and the mean of the corresponding readings of the small fixed gauge and the large fixed gauge set opposite, these being arranged for easterly and westerly winds.

Two points are to be noticed: (1) only one reading of more than 32·5 lbs. was registered, and this, it is practically certain, was due to faulty action in the gauge.

Sir B. Baker has kindly shown me some further records with a small gauge.

According to these pressures of more than 50 lbs. have been registered on three occasions since 1886. On two other occasions the pressures, as registered, reached from 40 to 50 lbs. per square foot. But the table, it will be seen, enables us to compare the pressure on a small area with the average pressure on a large area, and it is clear that in all cases the pressure per square foot as given by the large area is much less than that deduced from the simultaneous observations on the small area.

The large gauge became unsafe in 1896 and was removed; but the observations for the previous ten years entirely confirm this result, the importance of which is obvious. The same result may be deduced from the Tower Bridge observations. Power is required to raise the great bascules, and the power needed depends on the direction of the wind. From observations on the power some estimate of the average wind pressure on the surface may be obtained, and this is found to be less than the pressure registered by the small wind gauges. Nor is the result surprising, when the question is looked at as a hydrodynamical problem; the lines of fluid near a small obstacle will differ from those near a large one, and the distribution of pressure over the large area will not be uniform. Sir W. Siemens is said to have found places of negative pressure near such an obstacle. As Sir J. Wolfe Barry has pointed out, if the average of 56 lbs. to the square foot is excessive, then the cost and difficulty of erection of large engineering works is being unnecessarily increased. Here is a problem well worthy of attention, and about which but little is known. The same, too, may be said about the second of the Board of Trade rules. What is the effective surface over which the pressure is exerted on a bridge? On this again our information is but scanty. Sir B. Baker's experiments for the Forth Bridge led him to adopt as his rule, Double the plane surface exposed to the wind and deduct 50 per cent. in the case of tubes. On this point again further experiments are needed.

To turn from engineering to physics. In metrology, as in many other branches of science, difficulties connected with the measurement of temperature are of the first importance.

I was asked some little time since to state, to a very high order of exactness, the relation between the yard and the metre. I could not give the number of figures required. The metre is defined at the freezing point of water, the yard at a temperature of 62° F. When a yard and a metre scale are compared they are usually at about the same temperature; the difficulty of comparison is enormously increased if there be a temperature difference of 30° F. between the two scales. Hence we require to know the temperature coefficients of the two standards. But that of the standard yard is not known; it is doubtful, I believe, if the composition of the alloy of which it is made is known, and in consequence Mr. Chaney has mentioned the determination of coefficients of expansion as one of the investigations which it is desirable that the Laboratory should undertake.

Or, again, take thermometry. The standard scale of temperature is that of the hydrogen thermometer; the scale in practical use in England is the mercury in flint glass scale of the Kew standard thermometers. It is obvious that it is of importance to science that the difference between the scales should be known, and various attempts have been made to compare them. But the results of no two series of observations which have been made agree satisfactorily. The variations arise probably in great measure from the fact that the English glass thermometer, as ordinarily made and used, is incapable of the accuracy now demanded for scientific investigations. The temporary depression of the freezing point already alluded to in discussing the Jena glass is too large; it may amount to three- to four-tenths of a degree when the thermometer is raised 100°. Thus the results of any given comparison depend too much on the immediate past history of the thermometer employed, and it is almost hopeless to construct a table, accurate, say, to ·01, which will give the difference between the Kew standard and the hydrogen scale, and so enable the results of former work in which English thermometers were used to be expressed in standard degrees.

TABLE III.—*Values of Corrections to the English Glass Thermometer Scale to give Temperatures on the Gas Thermometer Scale found by various Observers.*

Temp.	Rowland.	Guillaume.	Wiebe.
°	°	°	°
0	0	0	0
10	− ·03	− ·009	+ ·03
20	− ·05	− ·009	+ ·00
30	− ·06	− ·002	+ ·02
40	− ·07	+ ·007	+ ·09
50	− ·07	+ ·016	+ ·14
60	− ·06	+ ·014	
70	− ·04	+ ·028	
80	− ·02	+ ·026	
90	− ·01	+ ·017	
100	0	0	

This is illustrated by Table III., which gives the differences as found (1) by Rowland; (2) Guillaume; (3) Wiebe between a Kew thermometer and the air thermometer.

It is clearly important to establish in England a mercury scale of temperatures which shall be comparable with the hydrogen scale, and it is desirable to determine as nearly as may be the relation between this and the existing Kew scale.

I am glad to say that in the first endeavour we have secured the valuable cooperation of Mr. Powell, of the Whitefriars Works, and that the first specimens of glass he has submitted to us bid fair to compare well with 16'''.

Another branch of thermometry at which there is much to do is the measurement of high temperature. Prof. Callendar has explained here the principles of the resistance thermometer, due first to Sir W. Siemens. Sir W. C. Roberts-Austen has shown how the thermopile of Le Chatellier may be used for the measurement of high temperatures. There is a great work left for the man who can introduce these or similar instruments to the manufactory and the forge, or who can improve them in such a manner as to render their uses more simple and more sure. Besides, at temperatures much over 1000° C., the glaze on the porcelain tube of the pryometer gives way.

So far we have discussed new work, but there is much to be done in extending a class of work which has gone on quietly and without much show for many years at the Kew Observatory. Thermometers and barometers, wind gauges and other meteorological apparatus, watches and chronometers, and many other instruments are tested there in great numbers, and the value of the work is undoubted. The competition among the best makers for the first place, the best watch of the year, is most striking and affords ample testimony to the importance of the work.

Work of this class we propose to extend. Thus, there is no place where pressure gauges or steam indicators can be tested. It is intended to take up this work, and for this purpose a mercury pressure column is being erected.

Again, there are the ordinary gauges in use in nearly every engineering shop. These, in the first instance, have probably come from Whitworth's, or nowadays, I fear, from Messrs. Pratt and Whitney or Browne and Sharpe, of America. They were probably very accurate when new, but they wear, and it is only in comparatively few large shops that means exist for measuring the error and for determining whether the gauge ought to be rejected or not. Hence arise difficulties of all kinds. Standardisation of work is impossible.

In another direction a wide field is offered in the calibration and standardisation of glass measuring vessels of all kinds, flasks, burettes, pipettes, &c., used by chemists and others. At the request of the Board of Agriculture we have already arranged for the standardisation of the glass vessels used in the Babcock method of measuring the butter fat in milk, and in a few months many of these have passed through our hands. We are now being asked to arrange for testing the apparatus for the Gerber and Leffman-Beam methods, and this we have promised to do when we are settled at Bushy. Telescopes, opera-glasses, sextants, and other optical appliances, are already tested at Kew, but this work can, and will, be extended. Photographic lenses are now examined by eye; a photographic test will be added, and I trust the whole may be made more useful to photographers.

I look to the cooperation of the Optical Society to advise how we may be of service to them in testing spectacles, microscope lenses and the like. The magnetic testing of specimens of iron and steel, again, offers a fertile field for inquiry. If more subjects are needed it is sufficient to turn over the pages of the evidence given before Lord Rayleigh's Commission, or to look to the reports which have been prepared by various bodies of experts for the executive committee.

In electrical matters there are questions relating to the fundamental units on which, in Mr. Trotter's opinion, we may help the officials of the Board of Trade. Standards of capacity are wanted; those belonging to the British Association will be deposited at the Laboratory. Standards of electromagnetic induction are desirable; questions continually arise with regard to new forms of cells other than the standard Clark cell, and in a host of other ways work will be found.

I have gone almost too much into detail. It has been my wish to state in general terms the aims of the Laboratory to make the advance of physical science more readily available for the needs of the nation, and then to illustrate the way in which it is intended to attain those aims. I trust I may have shown that the National Physical Laboratory is an institution which may deservedly claim the cordial support of all who are interested in real progress.

ON THE SEPARATION OF THE LEAST VOLATILE GASES OF ATMOSPHERIC AIR, AND THEIR SPECTRA.[1]

THE separation of these gases from each other was effected by collecting them in a bulb in the solid state and allowing the solid gradually to evaporate at as low a temperature as possible, while the vapour was continually pumped away with a mercurial pump. Between the bulb containing the solidified gases and the pump a sparking tube was interposed, where the spectrum emitted by the vapour under the influence of an electric discharge was from time to time observed.

The success of the operation of separating the gases which boil at different temperatures depends on keeping the temperature of the solid mass as low as possible, as will be seen from the following consideration :—

The pressure, p, of a gas G, above the same material in the liquid state, at temperature T, is given approximately by the formula

$$\log p = A - \frac{B}{T},$$

where A and B are constants for the same material. For some other gas G′ the formula will be

$$\log p_1 = A_1 - \frac{B_1}{T},$$

and

$$\log \frac{p}{p_1} = A - A_1 + \frac{B_1 - B}{T}.$$

Now for argon, krypton and xenon, respectively, the values of A are 6·782, 6·972 and 6·963, and those of B are 339, 496·3 and 669·2; and for these and many other substances $A - A_1$ is always a small quantity, while $\frac{B_1 - B}{T}$ is considerable and increases as T diminishes. Hence the ratio of p to p_1 increases rapidly as T diminishes, and by evaporating the gases always from the solid state and keeping the solid at as low a temperature as possible, the gas first coming off consists in by far the greatest part of that which has the lowest boiling point, and is succeeded, with comparative abruptness, by the gas which has the next higher boiling point. So abrupt indeed is the succession that the nitrogen is almost completely removed before the argon makes its appearance, and the necessity for removing the nitrogen by sparking with oxygen almost wholly avoided. The change from one gas to another is easily detected by examining the spectrum in the sparking tube, and the reservoirs into which the gases are pumped can be changed when the spectrum changes and the fractions separately stored.

The general sequence of spectra, omitting those of nitrogen, hydrogen and compounds of carbon, which were never entirely removed by the process of distillation alone, was as follows: The spectrum of argon was first noticed in succession to nitrogen, and then as the distillation proceeded the brightest rays, green and yellow, of krypton appeared, and then the intensity of the argon spectrum waned, and it gave way to that of krypton until, as predicted by Runge, when a Leyden jar was in the circuit, the capillary part of the sparking tube had a magnificent blue colour, while the wide ends were bright pale yellow. Without a jar the tube was nearly white in the capillary part, and yellow about the poles. As the distillation proceeded, the temperature of the vessel containing the solid mixture being allowed to rise slowly, the brightest of the xenon rays began to appear, namely, the green rays about λ 5420, 5292 and 4922, and then the krypton rays soon died out and were superseded by the xenon rays. At this stage the capillary part of the sparking tube is, with a jar in circuit, a brilliant green, and is still green, though less brilliant, without the jar. The xenon formed the final fraction distilled.

The authors give a long list of the approximate wave-lengths of rays they have observed to be emitted by xenon and krypton under the influence of electric discharge.

The variation of the spectra of both xenon and krypton with variation in the character of the electric discharge is very striking, and has already been the subject of remark, in the case of krypton, by Runge, who has compared krypton with argon in its sensitiveness to changes in the electric discharge. Runge distinguishes krypton rays which are visible without a jar and those which are only visible with a jar discharge. The difference in the intensity of certain rays, according as the discharge is continuous or oscillatory, is no doubt very marked, but, with rare exceptions, the authors have found that the rays which are intensified by the oscillatory discharge can be seen with a continuous discharge when the slit of the spectroscope is wide. Runge used a grating, whereas they have, for the sake of more light, used a prism spectroscope throughout, and were therefore able to observe many more rays than he.

There is one very remarkable change in the xenon spectrum produced by the introduction of a jar into the circuit. Without the jar xenon gives two bright green rays at about λ 4917 and λ 4924, but on putting a jar into the circuit they are replaced by a single still stronger ray at about λ 4922. In no other case have the authors noticed a change so striking as this on merely changing the character of the discharge. It is noteworthy that the ray λ 4922 is close to a well-known helium ray, but other helium rays were not seen in the same spectrum. Changes of the spectrum by the introduction of a jar into the circuit are, however, the rule rather than the exception, and there are changes in the spectrum of krypton which seem to depend on other circumstances. Of many tubes filled with krypton in the manner above indicated, some give with no jar the green ray λ 5571, the yellow ray λ 5871 and the red ray λ 7600 very bright, while other rays are very few, and those few barely visible. Putting a jar into the circuit makes very little difference; the three rays above mentioned remain much the brightest, nearly, though not quite, so bright as before, and the blue rays, so conspicuous in other tubes, though strengthened by the use of the jar, are still very weak. In other tubes the extreme red ray is invisible, the rays at λ 5571 and 5871 absolutely, as well as relatively, much feebler, while the strong blue rays are bright, even brighter than the green and yellow rays above named. In one tube the blue rays could be seen, though not the others. This looks very much as if two different gases were involved, but the authors have not been able to assure themselves of that. The case seems nearly parallel with that of hydrogen. There are some hydrogen tubes which show the second spectrum of hydrogen very bright, and others which show only the first spectrum; the second spectrum is enfeebled or extinguished by introducing a jar into the circuit, while the first spectrum is strengthened; and the conditions which determine the appearance of the ultra-violet series of hydrogen rays have not yet been satisfactorily made out.

It is to be noted that putting the jar out of circuit does not in general immediately reduce the brightness of the rays which are strengthened by the jar discharge. Their intensity fades gradually, and is generally revived, more or less, by reversing the direction of the current, but this revival gets less marked at each reversal until the intensity reaches its minimum. The rays strengthened by the jar discharge also sometimes appear bright, without a jar, on first passing the spark when the electrodes are cold, and fade when the electrodes get hot, reappearing when the tube has cooled again. Moreover, if the discharge be continued without a jar, the resistance in the krypton tubes increases rather rapidly, the tube becomes much less luminous and finally refuses to pass the spark. With an oscillatory discharge the passage of the spark and the brightness of the rays are much more persistent. This seems to point to some action at the electrodes which is more marked in the case of krypton than in that of xenon.

The xenon spectrum is characterised by a group of four conspicuous orange rays of about equal intensities, a group of very bright green rays of which two are especially conspicuous, and several very bright blue rays. The list of xenon rays published by Erdmann does not present any close agreement with that of the authors except as to the strongest green lines. The number of xenon rays observed is very considerable, and some of them lie very near to rays of the second spectrum of hydrogen, but inasmuch as these rays are more conspicuous with a jar in circuit than without, which is not the character of the second spectrum of hydrogen, and as, moreover, many of the brightest of the hydrogen rays are absent from the spectrum of the tubes, the authors conclude that these rays are not due to hydrogen.

Certain rays, tabulated separately, have been as yet observed in only one xenon tube; they include a very strong ultra-violet ray of unknown origin, and due either to some substance other than xenon or to some condition of the tube which has not been repeated in the other tubes.

[1] Abridged from a paper by Prof. G. D. Liveing, F.R.S., and Prof. J. Dewar, F.R.S., read before the Royal Society on June 20.

The authors' krypton rays agree tolerably closely with Runge's list, but outnumber his very considerably, as might be expected when prisms were used instead of a grating. The authors think that the krypton used by Runge must have contained some xenon, and that the rays for which he gives the wave-lengths 5419·38, 5292·37 and 4844·58 were really due to xenon, as they are three of the strongest rays emitted by their xenon tubes, and are weak in, and in some cases absent from, the spectra of their krypton tubes.

Appended to the paper are tables showing wave-lengths of xenon and krypton lines to four figures.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE University of St. Andrews has received information that a legacy of 4000*l.* has been left to it by the late Miss Malcolm for the establishment of medical bursaries and scholarships.

ACTING on the suggestion made by Mr. Chamberlain, the general purposes committee of the Birmingham City Council has resolved to recommend the Council to make a grant to the Birmingham University of the proceeds of a halfpenny rate. This will provide an annual sum of 5000*l.*

THE Agent General for New South Wales intimates that applications are invited from gentlemen qualified to fill the chair of pathology in the University of Sydney. Particulars may be obtained from the Agent General for New South Wales, 9, Victoria Street, London, S.W.

THE Technical Education Board of the London County Council has directed the higher education subcommittee to inquire and report (*a*) as to the need and present provision for special training of an advanced kind in connection with the application of science (especially chemistry and electricity) to industry; (*b*) as to what, if any, developments are needed to secure efficient training in these subjects for senior county scholars and other advanced students who desire to qualify themselves to take leading positions in scientific industries. The Board has arranged to make a grant of 10,000*l.* a year to the University of London, and is thus directly interested in the development of advanced scientific instruction in London.

SCIENTIFIC SERIAL.

American Journal of Mathematics, vol. xxiii. No. 3.—Geometry on the cubic scroll of the second kind, by F. C. Ferry, is the conclusion (34 pp.) of a paper commenced in the last number.—Congruent reductions of bilinear forms, by T. J. I'A. Bromwich, contains an account and a slight extension of a method due to Kronecker (*Gesamm. Werke*, Bd. i. p. 349). This method was employed in the first place for the reduction of two quadratic forms. In the present paper it is applied to four cases of reductions, viz. (1) two symmetric forms (the same as Kronecker's case); (2) a symmetric and an alternate form; (3) two alternate forms; and (4) two Hermite's forms. In cases (1)–(3) the substitutions are congruent, while in (4) they are conjugate imaginaries. Mr. Bromwich gives a list of the principal papers which deal with the problems he has considered in his article. On the imprimitive substitution groups of degree fifteen and the primitive substitution groups of degree eighteen, by E. Norton Martin, was presented, in abstract and in a slightly different form, at the summer meeting of the American Mathematical Society in 1899. Herein he has added two new groups to his original list, viz. the groups with five systems of imprimitivity simply isomorphic to the alternating and symmetric groups of degree five, and he mentions that Dr. Kuhn reported at the February (1900) meeting of the Society that he had carried the investigation further by adding twenty-eight to the seventy groups found by Mr. Martin. The list even now does not claim to be absolutely complete, since omissions are always possible. A somewhat long list of recent papers on the subject is appended to the article.—Removal of any two terms from a binary quantic by linear transformations, by Bessie G. Morrison, discusses these linear transformations and gives applications to the non-singular cubic, quartic, quintic and sextic.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, June 19.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—On the use of a geological datum, by Mr. Beeby Thompson. A proper interpretation of geological phenomena frequently requires that allowance shall be made for differential earth-movements that have taken place since the period under consideration. Present differences of level in rocks of the same age may be due to actual differences in depth of the sea-floor on which they were deposited; but they may also be the result of subsequent differential earth-movements. The rock selected as a datum should combine as far as possible the following characteristics:—It should be thin, of considerable horizontal extension, having similarity in physical characters and palæontological contents over a large area, and situated as near as possible, in vertical sequence, to the reference-deposit. In Northamptonshire three formations meet these requirements—the Rhætic Beds, the Marlstone Rock-bed and the Cornbrash. The author applies the Marlstone Rock-bed as a datum to the study of the five chief deep explorations in Northamptonshire, with the following results:—While the old land-surface (below the Trias) now varies in height by more than 250 feet, the variation in thickness of the rocks between it and the Middle Lias only reaches 56½ feet; and although the old land-surface is actually lowest where the Rhætic rocks have not been detected, when compared with the position of the Marlstone it is found to be the highest. The further application of the same method enables the author to recognise Rhætic rocks at Northampton, to correct the record of the Kingsthorpe shaft, and to explain the presence of Triassic saline water in the Marlstone. A revised section of the Kingsthorpe shaft is given. Another point proved is that a general levelling-up process was going on just before the beginning of the Lower Liassic Period, and another at the close of the Middle Liassic Period.—On intrusive, tuff-like, igneous rocks and breccias in Ireland, by Messrs. James R. Kilroe and Alexander McHenry.—Many fragmental igneous rocks, although resembling tuffs, cannot be regarded as ejectamenta on account of their character and mode of occurrence in the field. A series of sections is exhibited to illustrate how tuff-like masses invade black slate of Llandeilo age in the South-east of Ireland, generally adhering to the direction of bedding, but frequently cutting across it and detaching numerous pieces from the slate, which are more abundant near the margins of the intrusion than elsewhere.

PARIS.

Academy of Sciences, July 8.—M. Fouqué in the chair.—On new derivatives of benzylcamphor and benzylidenecamphor, by MM. A. Haller and J. Minguin. In continuation of previous researches it is now shown that the unsaturated acid, $C_6H_5-CH=CH\cdot C_8H_{14}\cdot CO_2H$, obtained by the action of hydrobromic acid on benzylidenecamphor, or by treating bromobenzylcamphor with alcoholic potash or ammonia, combines with a molecule of hydrogen bromide to form phenylbromohomocampholic acid, which, when warmed with hydrobromic acid in acetic acid solution, loses bromine and yields the corresponding hydroxy-acid. The action of bromine on dextrobenzylcamphor results in the formation of two stereoisomeric bromobenzylcamphors which yield benzylidenecamphor on treatment with alcoholic potash. Further bromination of benzylcamphor gives rise to unstable dibromo-derivatives which are converted by the action of potash into ortho- and para-bromobenzylidenecamphors; the para-compound forms bromophenylhydroxyhomocampholic acid on treatment with hydrobromic acid at 100°.—Osmotic pressure and its *rôle* as a protection from cold in the living cell, by M. D'Arsonval. At the low temperature of liquid air animal and vegetable tissues in general become extremely hard and friable, whereas the vitality of yeast and various pathogenic micro-organisms is not impaired even by several weeks' exposure to cold. In explanation of this fact it is suggested that the solidification of such minute cells is prevented by the enormous osmotic pressure exerted therein, and it is shown that in the case of yeast the osmotic pressure may be reduced by the action of hypertonic solutions of certain salts to such an extent as to destroy the power of resisting the influence of cold.—New nebulæ discovered at the Paris Observatory, by M. G. Bigourdan.—Observations of Hall's comet 1901(*a*) at the Rio de Janeiro Observatory, by M. H. Morize.—Solar observations at the Lyon Observatory during the first quarter of 1901, by M. J. Guillaume.—On the conjugate nets of orthogonal and isothermal curves, by M. Demartres.—On the use in series of disjunctive voltameters, by M. Ch. Pollak. A note on a previous communication by the author.—On manganic phosphates, by M. V. Auger. The phosphate obtained by heating manganese nitrate with phosphoric acid at 210° and extracting the fused mass with water has the composition $MnP_6O_{21}+14H_2O$, and is evidently a pyrophosphate; it is dissolved by phosphoric acid, forming a violet solution which soon becomes opalescent and deposits the normal phosphate, $MnPO_4+H_2O$. Manganese metaphosphate, MnP_3O_9, is obtained by heating phosphorus pentoxide with hydrated manganese dioxide.—Action of acid chlorides on methanal, by M. Louis Henry. The author confirms Descudé's recent observation that the presence of zinc chloride facilitates the action of acid chlorides on aldehydes. Benzoyl chloride alone has no action on methanal (trioxymethylene), but in the presence of zinc chloride a rapid reaction takes place with the form of a substance, crystallising in needles, which appears to be chloromethyl benzoate.—Action of vegetable alkaloids on some indicators, by M. A. Astruc. The behaviour of a number of alkaloids towards the indicators helianthin, rosolic acid and phenolphthalein was examined. In order to avoid the dissociating influence of water, ethyl alcohol, amyl alcohol and benzene were employed as solvents. The results obtained depend on the solvent used in each case, as well as on the nature of the alkaloid.—On dinaphthoxanthene, by M. R. Fosse. The action of bromine on dinaphthoxanthene leads to the formation of bromodinaphthoxanthene, a red, crystalline substance melting at 218–220°, which is remarkable in that when warmed with alcohol it undergoes a reaction similar to that exhibited by diazo-derivatives, hydrogen bromide, aldehyde and dinaphthoxanthene being produced. Bisdinaphthoxanthenamine, obtained by the action of alcoholic ammonia on the above-described bromine derivative, is a crystalline compound melting at 230°. Chlorodinaphthoxanthene crystallises in red needles melting at 150°.—Study of the product of the nitration of acetoacetic ether, by MM. L. Bouveault and A. Bongert. The compound previously described as produced by the nitration of acetoacetic ether is shown to be isomeric with, but quite different in its reactions from, the substance which Scholl obtained by the action of silver nitrate on ethyl bromacetate.—On a method of synthesis of acetylenic aldehydes, by MM. Ch. Moureu and R. Delange. The condensation of the ethers of formic acid with the sodium derivatives of true acetylenic hydrocarbons, $R-C\equiv CH$, leads to the formation of acetylenic aldehydes, $R-C\equiv C-CHO$, whilst the ethers of higher acids give rise to acetylenic ketones.—Attempts to render vegetables immune against cryptogamic diseases, by M. J. Beauverie. Seeds and cuttings grown in soil in which the fungus *Botrytis cinerea* had been previously allowed to develop were found to produce plants capable of resisting the action of the fungus.—On the *rôle* of leucocytes in elimination, by M. Henry Stassano.—Glucoproteins as new culture media, of definite chemical composition, for the study of microbes, by M. Charles Lepierre. Nearly all microbes, whether pathogenic or not, grow perfectly in liquids in which the nitrogen is furnished exclusively by glucoproteins.—The structure and function of the nervous system of an acephaloid, by MM. N. Vaschide and C. Vurpas.—Acoustic conductivity and audition, by M. Pierre Bonnier.—On the intermittent spring at Vesse, near Vichy, by M. F. Parmentier. The action of this spring lasts for a period of an hour and takes place three times in 25–27 hours. The water is thrown to a height of 7–8 metres and is accompanied by a copious evolution of carbon dioxide; it has a temperature of 31°, and yields a solid residue of 5·354 grams per litre consisting chiefly of sodium carbonate.

New South Wales.

Royal Society, May 1.—Prof. Liversidge, president, in the chair.—Mr. H. C. Russell, C.M.G., F.R.S., was elected president for the current year.—Prof. Liversidge delivered an address, in the course of which he referred to the Intercolonial Catalogue of Scientific Literature. This work, he said, would annually fill seventeen volumes, and would contain from 160,000 to 200,000 entries yearly, and would prove an inestimable boon, as it would relieve scientific people from much of the trouble now attendant upon hunting up references to scientific subjects. He trusted that some effort would be made to collect and forward material from Australia for inclusion in this catalogue. He was also strongly in favour of a federation of the leading scientific societies in Australia and the establishment of a national Australian academy, and suggested that a site for such an academy, museums, art galleries, and a Federal University and other scientific and educational societies might be reserved in the capital of the Commonwealth. The organisation proposed would somewhat resemble the Continental academies so far as its scope was concerned, but under rules more like those of the Royal Society of London. If the proposal were carried out it would be of great benefit to Australia, not only in its general usefulness, but in the stimulus it would give to the younger scientific men, since election to it would depend upon fitness and merit. It would be very gratifying to all who were interested in the matter if, with the new century and the inauguration of the Commonwealth, there was increased attention paid to the question of instruction in science in the schools and better provision made in this direction, for it would be of great usefulness in training the power of observation of the children and teaching them to think about what they saw and heard. Some of the teaching now done at the University should be given in the schools, and the student would then gain valuable time at the University for things he could not do at school. He did not advocate the teaching of technical or applied sciences in ordinary schools. It was to be regretted that the Sydney University was probably the only modern University that excluded science from its entrance examinations. Prof. Liversidge also made some observations in connection with the advantages of a metric system of weights and measures and a decimal system of coinage. He strongly recommended that its teaching should be compulsory in all the schools of the State. The chief defect of our present system of weights and measures was that there was no simple connection between measures of length, weight and capacity. Investigation showed that in countries where the change to the metric system had been made, no great difficulty was experienced, and an increase of trade had resulted. He strongly urged that increased attention should be paid to commercial education and suggested that, not only should it include a certain amount of instruction in science, but that the standard for the higher branches should be as high as for any of the learned professions, also that part of the course should be given at the University.

CONTENTS.

THURSDAY, JULY 25, 1901.

ANOTHER BOOK ON BRITISH BIRDS.

A Handbook of British Birds. By J. E. Harting. New and Revised Edition. Pp. xxxi + 520; 35 plates. (London: John C. Nimmo, 1901.) Price 2*l.* 2*s.* net.

IT is now some years since the first edition of this book appeared. The present volume, Mr. Harting points out, is nearly treble the size of the original; and, we might truthfully add, is proportionately as interesting.

The author claims for it that,

"as an attempt to show, in one volume, the precise status of every so-called British bird, distinguishing the rare and accidental visitants from the residents and annual migrants, it conveys information of a kind which is not to be found in any other work on British birds."

Be that as it may, the present volume will prove a valuable addition to the library of every working ornithologist. More especially, perhaps, this book will appeal to the outdoor naturalist and to the "collector." But the "cabinet" naturalist will feel himself scarcely less in need of this work, for scattered throughout its scholarly pages will be found innumerable instances of Mr. Harting's intimate knowledge of his subject, both in the fields of bionomics and of literature.

It is obvious that, in a book of this kind, some sort of systematic arrangement must be followed, and Mr. Harting has been confronted with the difficult task of deciding which of the numerous systems of classification that have from time to time been proposed should be adopted in the present volume. His choice has fallen upon the one more or less in favour during the early part of the nineteenth century. A great feature of this system is the prominence given to the accipitrine birds. Mr. Harting justifies his choice in the following words:—

"The most striking character which distinguishes birds from all other vertebrates (save the *Chiroptera*) is the power of flight, and since that peculiarity is most highly developed in the falcons, which are able to overtake and capture the fastest birds upon the wing, not even excepting swallows and swifts, it seems not unreasonable on this account, if for no other, to place the raptorial birds as the highest type of the class *Aves* at the head of any scheme of classification."

Mr. Harting's contention most certainly demands our serious consideration. Nevertheless, to many the revival of this claim to preeminence for the Raptores will seem reactionary, especially to those who, after mature deliberation and ripe experience, are convinced that the headship of the class Aves must be vested in the Passerine forms, the Corvidæ standing as the type.

Strangely enough, one of the strongest supporters of the last-mentioned view, Prof. Newton, is retained, so to speak, by Mr. Harting for the other side. Justification for this is made out on the ground that Prof. Newton followed this precedent when editing the fourth edition of Yarrel's "British Birds" in 1871. But Mr. Harting has overlooked the fact that since that date the editor of this famous book has changed his views; so that in 1884 we find him, as we have just indicated, a doughty champion for "the new learning." The thirteen years that elapsed between the publication of the fourth edition of Yarrell and the masterly article in the "Encyclopædia Britannica" were memorable years in the annals of ornithology—memorable because of the brilliant work of Parker, Garrod, Gadow and Forbes; and no student of ornithology, least of all Prof. Newton, watching the development of their researches could fail to be impressed with the facts they brought to light, and, being impressed, could resist the conclusions to which these appeared to lead.

But seventeen years have elapsed since the "Encyclopædia" article was written, and in these days of prolific publication we are apt to lose sight even of the many gems buried in these ponderous tomes. Happily for us, the substance of Prof. Newton's article, "Ornithology," was incorporated in the introduction to his "Dictionary of Birds"—a book which has been aptly described as marking "an epoch in ornithology"—wherein it was probably read by many for the first time. Since this is the more accessible of the two, we will quote what Prof. Newton has to say, therefrom. In his introduction to this work, in dealing with the Passeres, he writes, "Thus we reach the true *Oscines*, the last and highest group of birds." Further on he quotes, in the strongest terms of approval, Prof. Parker's dictum, that

"In all respects, physiological, morphological and ornithological, the crow may be placed at the head, not only of its own great series (birds of the *Crow-form*), but also as the unchallenged chief of the whole 'Carinatæ.'"

And finally, towards the conclusion of the introduction, he writes:—

"It is therefore confidently that the present writer asserts . . . that at the head of the class *Aves* must stand the family *Corvidae*, of which family no one will dispute the superiority of the genus *Corvus*, nor in that genus the preeminence of *Corvus corax*—the widely ranging raven of the northern hemisphere."

Whether the crows and the forms associated therewith will be allowed to retain this preeminence—which is to-day generally recognised—time will show. This darkly suggested insecurity of tenure will come probably as a relief to Mr. Harting. He may further take heart of grace in that this indication of a "rift within the lute" has come from a no less qualified authority than Mr. Beddard, who suggests ("Classification of Birds," 1898) that the Passeres and their allies should, perhaps, be rather regarded as primitive, archaic types. "More especially," he writes, in the opening words of the discussion on this subject, "does it appear to me that ornithologists are in error concerning the position of the picarian and passerine birds," and he proceeds to adduce a number of reasons which tend to support this view—reasons which are weighty, and which demand a very careful examination from every aspiring taxonomist.

It will be perceived from the foregoing that the relative positions of the different groups of birds, one to another, are yet by no means clearly defined; therefore, until systematic ornithology assumes a more definite shape, Mr. Harting may fairly claim the right to choose for his book that arrangement which most nearly meets his own views.

In dealing with the systematic position of the swifts and swallows, Mr. Harting will again find himself in opposition to the views held at the present day, at least in this country. Mr. Harting will have it, as some have done before him, that the swifts and swallows are near akin, and brings forward in support of this contention the views expressed by such undoubted authorities as the late W. K. Parker and Mr. F. A. Lucas. But on the other side we have a still greater weight of authority, greater if only in point of numbers, no less than seven ornithologists, whose names are as household words among us, having emphatically committed themselves to the conviction that the swifts are near allies of the humming-birds. These illustrious seven are Beddard, Furbringer, Gadow, Garrod, Newton, Sharpe and Stejneger. About the finality of their decision there can be little doubt.

Other points in the scheme of classification adopted by Mr. Harting would furnish material for comment did space permit, but these are of comparatively minor importance.

In the matter of nomenclature, Mr. Harting will be accused of unorthodoxy; but in much of what he has done in this matter, and in his defence thereof, he has our sympathy.

Orthography and etymology are conspicuous features of this book, and many of Mr. Harting's observations under these heads are extremely interesting. His scholarly handling of these difficult matters will impress every reader of this work. An immense amount of labour must have been spent in digging in this, to most of us, very uninviting field. But the results undoubtedly are well worth the trouble which has been expended.

The field-notes, as might have been expected from Mr. Harting, are exceedingly interesting. We cannot help thinking that in places these could with advantage have been enlarged upon. The author is one of the favoured few who has watched the bittern in the act of "booming." This remarkable noise is, we now know, produced whilst the beak is pointed vertically upwards, an attitude commonly assumed by this bird. Till recently it was generally held that the "booming" of the bittern was made whilst the beak was thrust down either into the mud or water.

The "drumming" or "bleating" of the snipe naturally calls forth some comment from the author. Opinions differ still as to the mechanism by which this is produced. The author is confident that it derives its origin from the vibration of the primaries. Meeves, it will be remembered, contended that it owed its origin to the vibration of the outer tail feathers, which have peculiarly thickened shafts. Still later observers have tried to show that it is due to the operation of both wings and tail, a violent current of air being driven through the tail feathers by the rapid vibration of the wings.

The introduction of coloured plates constitutes a new feature in this handbook.

"They have been executed in response to a repeated demand for a book on British birds with accurately coloured plates *in one volume*."

This, it is contended, it has been possible to do by figuring the head, and sometimes the foot, only. But this demand was surely for a book giving more or less lengthy diagnostic characters, *supplemented* by coloured plates. Mr. Harting's book does exactly the reverse, for his diagnoses, which are rare, are supplementary to the plates. No one would, of course, object to this if the plates completely fulfilled their purpose. This they fail to do, inasmuch as several undoubted British birds are not figured at all. Even if the missing heads were added, the book would still be lacking, for more immature stages are necessary, and some heads must be re-drawn, being quite inaccurate. These latter, however, are very few in number.

There are thirty-five plates in all, stated in the title-page to be "from the original drawings by the late Prof. Schlegel." Only a few of these, however, are by Schlegel, the majority having been drawn by Keulemans many years ago, and some are copied from Wolf. Their arrangement must have been entrusted to a foolish person, for a more stupid, exasperating distribution would have been impossible. Instead of being placed at the end of the book, they are distributed between every ten pages of so. Thus the plate illustrating the buntings faces the text dealing with the sand grouse and capercallie, that containing the finches is intercalated between the text devoted to the pheasant, the small wading birds faces the description of the wild-duck, and so on!

But these are minor blemishes in a work of considerable value, blemishes easily remedied in a second edition which is almost sure to be demanded. The binding, printing and paper leave nothing to be desired, and the book, judged as a whole, should take high rank in ornithological literature. W. P. P.

PRACTICAL PHYSIOLOGY.

An Introduction to Physiology. By William Townsend Porter, M.D., Associate Professor of Physiology in the Harvard Medical School. Pp. xvi + 314. (Cambridge, Mass.: The University Press, 1901.)

THIS new text-book of practical physiology is interesting from two distinct points of view. It is the first important work on the subject which has appeared by an American author, and the faculty for the invention of simple yet efficient mechanical devices which is characteristic of Americans is here reflected in clearly written descriptions of inexpensive apparatus which will, in large part, be novel to the British physiologist, who has, unfortunately, grown up to believe that adequate instruction cannot be given in physiology without expensive and elaborate apparatus and laboratory fittings. But the book has other importance, in that it is an indication of the extent and nature of the teaching that can be given to the medical student under the new system of dealing with the purely scientific subjects of the medical curriculum which has recently been inaugurated at the Harvard Medical School.

The present is a most opportune time to consider any new schemes which have appeared in other lands for the teaching of these "preliminary and intermediate medical studies," as the new London University styles them, when there is so much vexation and anxiety of heart as to how concentration of teaching and saving of labour may be effected under some general scheme which will give the reconstituted University of London a medical faculty in living reality, and not merely one which exists as a coherent body only in a printed list.

If one may judge by the extent of Prof. Porter's text-book, the Harvard student is taught a wider course of practical physiology than is attempted to be taught at any of our London medical schools, and, further, if he be taught the subject in the carefully inductive manner outlined by the author in his preface, he also obtains much more true scientific training in addition to this more extensive course. The latter point is the more important of the two, for, as Prof. Porter truly puts it in his preface, "the student should be trained rather than informed," for "the trained observer can, and must, be trusted to inform himself."

This wider course is covered in a period of four months, while in this country the student of medicine spends two years over physiology. Things do go proverbially quick in America, but this is not the reason for the disparity in time; the explanation is that the Harvard man spends *all* his hours of study during those four months upon physiology, whereas in this country the medical student's time is spent in attempting to make an intimate mixture of physiology, anatomy, organic chemistry and therapeutics. At the end of the two years the result is that the British student has wasted much time in hopping about from one branch of the tree of knowledge to another, and has not spent a sufficient interval at any one sitting upon any particular branch to gain much real benefit from it. So that finally he neither knows much of the experimental facts of any one of the subjects, nor, which is of more importance still, has he gained any training in scientific method or been imbued with any of the modern spirit of scientific inquiry or research.

His weary brain has been enslaved at unpalatable task-work all the two years, grinding up, at the same time, all four of these important subjects so that he may make answer to stock questions upon them at examination time. He is not judged at all by his character as a student known to his teachers, for the good or bad work that he has turned out during that period, or for any talent or originality that he has shown. There is no attempt, nor is there time for any attempt, to allow him to show what subject he loves; indeed, the system is calculated to make him hate them all instead. He must simply grind and be ground to the same stereotyped pattern as all his fellows; he must, in short, read and struggle to pass his Inter. M.B. Ask any of these men what he is doing at any part of the period and you will hear, not that he is studying anatomy or physiology or any of the other subjects, but that he is going up for his "Inter." at such and such a date; the dominant idea is the woeful examination and how best to get through it, and not any attraction for, or interest in, his subjects of study.

For the continuance of this condition of things the teachers, and not the students, are responsible. When we introduce a rational system of studying these subjects, which will teach our students to think, to examine critically the work done by others who have gone before them and to make attempts to proceed farther by themselves, a new era will dawn in which students will take an interest in their work and will rejoice in knowing that they will be judged on what they have been doing throughout their course, and not upon the extent to which they have impaired their memories and intellects by merely memorising the opinions of other men from their text-books and lectures.

Contrasted with the scientific progress of our time, the maintenance of our present system of examinations, and the perversion of the work of our costly laboratories into mere preparation for them, instead of teaching these subjects as a training in scientific observation and research, may truly be described as conservatism run to seed.

If it be granted that our main object ought to be, during these earlier years, to give the student a training in the methods of scientific investigation in the broad field of biology, and not to cram his mind with experimental facts gathered from the text-book or lecture-room, then the system introduced at Harvard of studying one subject thoroughly at a time and, when this has been mastered, from the point of view expressed above, passing on to the next, is undoubtedly a move in the proper direction. This is more especially true in the case of the branches of biological study where a knowledge of one subject is required before another can be advantageously taken up; where there is, so to speak, a definite *natural* order in which the subjects should be taken up. The writer's one experience under our present system, to give an example, is that the first two months or more of attendance on lectures in physiology are absolutely wasted, because the student begins his study of anatomy at the same time as physiology; if he completely finished his anatomy before he came to physiology, and then had all his time for physiology, our task would be much lighter, nor would the student be handicapped at all in his study of anatomy by not having learnt his physiology. Again, he ought to have completed a course on cellular physiology and done all his minute anatomy or histology, including his practical work in histology, before he commences to study the physiology of the mammal.

Further, what advantage accrues from studying a number of subjects at the same time? The student cannot possibly become absorbed in one and grow to enjoy really the study of it, because he feels that his other subjects are becoming cold from neglect. He must, therefore, turn about from one to another, and surely no scientific progress can be made by reading in such a scrappy fashion. The person who can do it with conspicuous success is certainly not the kind of person we want to encourage; yet for such intellectual weeds we arrange a system which chokes out, or does the best that can be imagined to choke out, our choicest flowers. This furnishes a sufficient clue to the well-known observation that our men of highest genius in the past have often been those that the schools rejected, or found no occasion to honour.

The conscientious student who starts simultaneously the study of anatomy, physiology, organic chemistry and materia medica under our present system is surely to be pitied. He hears a lecture in anatomy and tries to take some interest in this; he passes on to one, say, in organic chemistry, and for the time switches his attention off anatomy on to organic chemistry; next he turns his mind to physiology, and finally, weary and baffled, he probably sleeps through a lecture on the preparations of morphia of the British Pharmacopœia. Such intellectual juggling gives the student an acquaintance with the jargon of science, but of scientific method and scientific spirit it most assuredly teaches him nothing.

Every text-book of practical physiology must necessarily be written primarily to suit the requirements of a particular laboratory and a particular teacher, since the types of instrument used in different laboratories vary much, and the selection of experiments chosen by different teachers is also a very variable quantity. Prof. Porter's book has been written to suit the requirements of the Harvard course, and a number of the instruments described have been devised by himself for that course and with a special view of combining economy with efficiency. In nearly all cases, however, the experiments described can easily be adapted to the forms of apparatus used in this country, and the directions are clear and easily followed.

The large number of simple sketches showing the student how to arrange his apparatus is a novel and important feature of the book. This is a great improvement on the usual photographs of apparatus seen in most text-books of practical physiology hitherto published, which are of no service, because the student sees the apparatus on the laboratory table before him, and on the reproductions of tracings, which have little value, since the student obtains copies for himself in the course of his work. In all cases in this book the illustrations are designed to aid the student in understanding what he is asked to do, and are not intended merely for ornament, although they are, at the same time, well drawn and reproduced.

The book is divided into two parts, of which the first treats of the physiology of nerve and muscle, and the second of the circulation of the blood. The first section is much the longer of the two, and includes many experiments which are not usually attempted in this country by the student, but are nevertheless well within his power and very instructive; as examples of this may be cited, the stimulation of involuntary muscle, polar stimulation of the heart, galvanotropism, the effect of calcium salts upon skeletal muscle, idiomuscular contraction, summation of inadequate stimuli, and the stroboscopic method of demonstrating the action current of tetanus. The second section, although shorter, also contains several experiments hitherto novel to the usual student's course.

On the whole, it may be said that the book is clearly written in an original style, and is a welcome departure from the hackneyed treatment of practical physiology which is usually presented to the student.

BENJAMIN MOORE.

AN AMERICAN INTRODUCTION TO BOTANY.

Plant Studies. An Elementary Botany. By John M. Coulter, A.M., Ph.D., Head of Department of Botany, University of Chicago. Pp. vii+392. (London: Henry Kimpton, 1901.) Price 7*s.* 6*d.* net.

DR. COULTER'S work is one of the kind now in fashion, as it is a text-book for beginners that deals argely with the bionomics or œcology of plants. The study of œcology is, beyond doubt, of value to beginners in that it immediately establishes a sympathetic interest in the plant as a living organism, which has wants to satisfy, a policy to pursue and warfare to wage. Yet a scientific survey of a plant's life in relation to environment is, in most respects, possible only after a thorough investigation into the physiology and structure of many plants; in other words, an œcological truth is rarely susceptible of brief and simple proof. Consequently, in placing this branch of the subject before the student at the outset of his studies there is always a danger of cramming the beginner with principles of which no adequate proofs are given, or indeed possible at that stage. In a work of small size like the one before us it was impossible for the author to give proofs of more than a few principles, and he has elected to lay stress rather upon the illustration of principles than upon their accurate demonstration. The work is therefore hardly adapted to serve as an introduction to scientific botany for the use of students working without a teacher's aid; nor does Dr. Coulter intend that it should so serve; he states definitely that the book is intended to supplement the teacher, the laboratory and field-work.

The first 220 pages are concerned in the consideration of the general œcology of plants and of special "societies" (hydrophytes, mesophytes and xerophytes). Though the views expressed are for the most part those to be found in the works of Kerner, Warming and Schimper, there are not wanting cases in which the author enunciates views that are unwarranted; for instance, very dubious in relation to the protection of flowers is the significance of the water reservoirs of the teasel and of *Bilbergia* (p. 136). Lacking in proof, too, is the statement, "In certain parts of the tropics the air is so moist that it is possible for some plants to obtain sufficient moisture from this source, without any soil-relation or water-relation" (p. 98). On p. 123 the term cross-pollination is made to include geitonogamy despite of the different physiological effects of the two processes.

While arousing interest and stimulating a certain kind of intelligent observation, the book hardly encourages close reasoning or accurate language. It is ever a question as to when the rigid precision of technical terms may give place to vague elasticity of more familiar language. And in this respect the author can hardly be congratulated. Such expressions as "earth influence" (in relation to geotropism), "light influence" (in relation to heliotropism), "soil roots," "water roots," "air roots," "soil-related," "leaf-related," "light-relation," "life-relation," "life-process," "seed plants," though strongly reminiscent of the Fatherland, hardly seem to be improvements either on ordinary English or on appropriate technical expressions. At times, indeed, it is not easy to grasp the meaning of some of the sentences; for instance, after telling us that a root "is either an absorbent organ or a holdfast, or very often both," the author continues, "For such work no light-relation is necessary, as in the case of foliage leaves; and there is no leaf-relation, as in the case of stems" (p. 89).

The latter half of the book briefly considers selected groups of cryptogams, and gives an outline of the general characters of "flowering plants," which last Dr. Coult terms "spermatophytes."

Dr. Coulter's work is richly and excellently illustrated, a number of the illustrations being original. For this reason, and, further, because the author touches on questions elsewhere treated only in much larger works, the book may be found useful to such students as can employ it, as Dr. Coulter intends, merely to supplement the theoretical and practical instruction of a competent teacher.

OUR BOOK SHELF.

B. Eyferth's Einfachste Lebensformen des Tier- und Pflanzenreiches. Naturgeschichte der mikroskopischen Süsswasserbewohner. Dritte, vollständig neubearbeitete und vermehrte Auflage. Von Dr. Walther Schönichen und Dr. Alfred Kalberlah. Pp. 700. Taf. 16. (Brunswick: Benno Goeritz, 1900.)

THIS new edition of Eyferth's work will no doubt be of great use to students of microscopical forms of both vegetable and animal life. It includes representatives of most of the European families and genera of minute plants and animals, and there are sixteen excellent photographic plates giving typical illustrations of the genera. The nomenclature adopted for the botanical sections is that of Engler and Prantl in their "Natürliche Pflanzenfamilien," and the authors state that all recent additions to this branch of scientific literature have been taken into consideration, more especially with regard to results and conclusions arrived at by special workers at the various groups. The species enumerated, and to which are appended short descriptions, are stated to be representative ones about which there is no uncertainty of determination; but in the family Desmidiaceæ the species included are by no means representative, many of the very commonest ones being left out in preference for others which are uncommonly rare and hardly likely to be observed by the ordinary student of microscopical forms of life, for which person the book is undoubtedly written. One also wonders at the inclusion of Naegeli's genus *Oocardium* amongst the Desmids, and the presence of such useless genera as *Holocanthum*, *Schizocanthum*, *Pleurotaeniopsis* and *Pleurenterium*, which are introduced directly from Engler and Prantl. A most typical genus of the blue-green algæ—*Gloeochaete*—is placed in the Rhodophyceæ, and so is *Porphyridium*, which has most claim to be regarded as a reddish form of a blue-green, Aphanocapsa-like alga. The animal sections are given rather more completely than the vegetable, but the nomenclature of the Sarcodina seems to be considerably erroneous. The systematic position of *Hydrurus foetidus* amongst the Protozoa is truly remarkable.

G. S. WEST.

Handbook of British, Continental and Canadian Universities, with special mention of the Courses open to Women. Supplement for 1901. Compiled for the Graduate Club of Bryn Mawr College by Isabel Maddison, B.Sc., Ph.D. Pp. 70. (Pennsylvania: Bryn Mawr College, 1901.)

THIS is a supplement to a handbook published in 1896 to show the courses open to women in universities. As practically all European universities and colleges are now open to women, the original title was modified when a new edition was called for in 1899, and the book has become a short guide showing for the benefit of men as well as women the university systems, requirements, &c., of various countries. The present supplement contains corrigenda and addenda, bringing the handbook up to date as regards the lists of professors, lectures and the constitutional changes. Though the book is not to be compared with the Minerva Jahrbuch in point of value for reference, it may be of service to educationists interested in the facilities for the higher education of women.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Subjective Lowering of Pitch.

MR. SHERWOOD (p. 233) seems to have misunderstood my meaning. I did not intend to imply that a singer should be conscious of his own flatness (*i.e.* if loudness causes subjective lowering of pitch), but that his voice, being relatively loud to himself, should sound to him flatter than it really is; and that he would try to counteract the impression by singing sharp. This is the reverse of experience. A singer having a good ear for external music, but singing flat, evidently hears his own voice *sharper* than it really is. Such a singer keeps his voice up better in a chorus, or when the accompaniment is loud enough to produce a subjective impression as strong as that of his own voice.

Malvern, July 14. F. J. ALLEN.

Phototherapy.

As stated in NATURE, July 11, p. 259, Prof. Finsen of Copenhagen proposed, in 1893, that patients suffering from small-pox should be kept in rooms from which the chemical rays of light are excluded by means of red curtains or red glass. He was anticipated in this treatment by John Gaddesden, who wrote the famous medical treatise "Rosa Medicinæ," and died A.D. 1361. He cured a son of King Edward I. of small-pox by wrapping him in scarlet cloth in a bed and room with scarlet hangings. He says of the result, "est bona cura; et curavi eum in sequenti sine vestigio variolarum," "Dict. of Nat. Biogr.," and "Biographie Générale." M. H. CLOSE.

THE CONGRESS ON TUBERCULOSIS.

FOR some time past most elaborate preparations have been made for this Congress, and latterly it was feared that, owing to the postponement that was necessary on account of the death of Queen Victoria, the attendance, especially of workers from abroad, might be seriously affected. Fortunately, this anticipation has not been realised, and from the list of delegates and the number and importance of the papers promised there appears to be every prospect of a most successful and useful series of meetings.

If the work of the Congress was to be of an educational nature, it could scarcely be hoped that much time could be devoted to new work; and that it would be educational in the best sense of the word soon became evident. Certainly few congresses have succeeded in arousing such interest in matters affecting the health and general welfare of the community.

From the King, who gave his patronage, to the numerous municipal representatives and delegates of learned and philanthropic societies all classes seem to be represented; and that the interest aroused is not merely on paper is evident from the list of those who were present at the opening meeting on Tuesday. The Duke of Cambridge presided at the command of the King, and was supported by the American Ambassador and other Ministers and Ambassadors, the Duke of Northumberland, Earls Derby, Cawdor, Spencer and Cadogan, Lord Lister, the Lord Mayor and a whole host of distinguished scientific men. The Colonies were well represented by Lord Strathcona, Sir Andrew Clarke, Sir Walter Peace and others, whilst the Foreign delegates numbered between two and three hundred. The work of bringing a goodly company together had evidently been in competent hands. Will the work of the Congress be equally good? So far this question may be answered in the affirmative; and should the rest of the meetings be as successful as those of the first and second days, the Congress will have thoroughly justified its existence.

The Secretary General in his opening report referred to the Pathological Museum as one of the chief educational works of the Congress, and there can be little doubt that no such collection of tuberculous specimens has ever before been brought together. Every known tuberculous lesion in man and in the lower animals is illustrated, and every bacillus that in the smallest degree resembles the tubercle bacillus is represented. Classical specimens of Potts, Addison and Astley Cooper are all shown, and of specimens of later date a really typical collection has been made. After other features in the history of the Congress had been alluded to by the Secretary General, the Congress was declared open and a telegram was sent to the King. An answer to this telegram, wishing the Congress all success, came before the close of the meeting. The delegates were then addressed by the Marquis of Lansdowne, Earl Cadogan, the Lord Mayor of London, Lord Strathcona and Lord Lister, whose remarks are reported by the *Times* as follows:—

He said they met under immeasurably happier auspices than could possibly have been the case not many years ago. Thanks to the labours of the illustrious man who would address the general meeting on the following day, they now knew the enemy they had to deal with, which before the discovery of the tubercle bacillus was shrouded in impenetrable obscurity. They also knew, thanks to Pasteur, that that microbe was incapable of originating *de novo* in the human body; that, while some constitutions were more prone to its invasion than others, it must always be derived from similar organisms in the external world. Hence there came to be opened up the splendid prospect of the prevention of tuberculosis. But it was by no means only prevention that they were looking at. They also aimed in the present day at the cure of consumption. In this respect matters were very much more hopeful than they had been till quite recently. The physician might learn a great deal in this point of view from the experiences of the surgeon. There were a great many surgical complaints which they now knew to be just as much tubercular as pulmonary consumption—that was to say, they were just as much due to the growth of the tubercle bacillus. Yet the surgeon knew that in many of these cases the disease might be completely cured; that, in consequence of the means—of which they were getting to know more and more every day—which the animal organism had of resisting microscopic invaders, the tubercle bacillus was not only arrested in its progress, but swept away altogether, and the result came to be a healthy state of the tissues and parts in which it was. These experiences showed that tuberculosis was not necessarily an incurable disease. That was an immense point to have demonstrated. Thus, they were not surprised to learn that physicians were coming to look upon the cure of consumption more hopefully than they used to do, by treating it on recognised principles and on the same broad, general lines as surgical tuberculosis. For his own part, as a surgeon, he had had cases of pulmonary disease brought but little under his notice; but he had been surprised, even in his limited experience, at the numerous cases among his own patients in which people who many years ago had consumptive lungs had subsequently become free from all traces of the disease and had lived healthy, robust and useful lives. These cases he ventured humbly to regard as cases of cure of consumption. Then there were attempts now being made by the use of various specific means to deal with consumption even in its more advanced forms. He must not refer to that at the present time further than to say that some of them at least had very promising aspects. They might be sure that these means would be most carefully considered by the Congress, and he need not say how cordially he hoped and anticipated that their deliberations would be fraught with good. There was another point in which he believed the Congress would be useful besides the concentrated wisdom of the eminent men who had come as delegates to take part in it. If the prevention of tuberculosis was to be effectively carried out, the general public must aid the physician and the surgeon in the endeavour. He anticipated that that splendid gathering of scientific men from all parts of the world, meeting under Royal patronage, for which he might venture to express their profound gratitude, would indicate to he public the vast importance of the work they were engaged in and would lead to their cooperation in the endeavour to minimise and possibly eventually to stamp out entirely the greatest scourge of the human race.

Some idea of the standing of the delegates may be gathered from the following list of those who were presented to H.R.H. the Duke of Cambridge, and who spoke, each on behalf of his nation:—Prof. Osler, from the United States of America; Prof. von Schrötter, Austria; M. le Senateur Montefiore Levi, Belgium; Prof. Charles Gram, Denmark; Prof. Brouardel, France; Prof. von Leyden, Germany; Prof. Thomassen, Holland; Prof. Frédéric Koranyi, Hungary; Sua Eccellenza Senator Enrico di Rienzi, Italy; Prof. Holmboë, Norway; Prof. Cortezo, Spain; Prof. Hofmarshal Printzsjöld, Sweden; Dr. Louis Secretan, Switzerland. Greece and Roumania were also represented, as well as the Universities and all the medical societies and public health bodies in the kingdom.

The work of the Congress has been arranged in four sections. In the first all questions concerning the relations of the State and municipalities to the prevention of tuberculosis are to be discussed, and if the number of papers announced is any criterion, little should remain undiscussed at the conclusion of the Congress. The second section deals with medicine, including climatology; the third with pathology, including bacteriology; and the fourth with tuberculosis in animals.

In addition to the purely sectional work, three general addresses will be given. The first of these, by Prof. Koch, of Berlin, dealing with the preventive measures to be taken in connection with tuberculosis, is printed in full in this number; Prof. Brouardel, of Paris, will give the second address; and Prof. McFadyean, of the Royal Veterinary College, the third. Prof. Koch is also announced to open a discussion on tuberculin—a discussion that should be of a very interesting character.

The "social" programme is unusually attractive, but in no way interferes with the efficient working of the important or business meetings of the Congress. We shall watch with interest the further proceedings of the Congress.

THE LIQUEFACTION OF HYDROGEN.

THE liquefaction and solidification of hydrogen form the last of the definite stages, so far, in the progress towards the absolute zero of temperature. To make the account of this stage clear, it will be necessary to compare it briefly with those which preceded it.

During the third decade of the last century, Faraday found that, whereas different substances have different boiling-temperatures at ordinary pressure, or different condensation-pressures at ordinary temperature, the lowest boiling point could be lowered further by reducing the pressure artificially. Thus by exhausting with a vacuum-pump the vapour from a vessel containing solid carbonic acid, he was able to obtain cold intense enough to liquefy a large number of gases exposed to the low temperature and, at the same time, to considerable pressure. This may be called the vaporisation method of cooling. Pictet in 1877 showed how its effect might be intensified by using the cold so obtained by the low-pressure boiling of one substance, such as sulphur dioxide, to condense at high pressure some more volatile gas, such as carbonic acid, the subsequent boiling of which at reduced pressure would produce a further reduction of temperature. The successive falls of temperature obtained in this way have caused this to be known as the cascade system of refrigeration. Pictet himself thought that by this means he succeeded in liquefying and solidifying hydrogen, and, though this was probably a mistake, the method has proved a very useful one. By the choice of more suitable substances, carbonic acid and ethylene, Wróblewski and Olszewski in 1883 succeeded for the first time in cooling oxygen or air to such a low temperature that under moderate pressure it condensed and remained as a visible liquid, of which, when it was allowed to boil at ordinary pressure, a portion remained liquid at a lower temperature. This cascaded vaporisation method, the direct descendant of Faraday's system, was subsequently used by Dewar in improved apparatus on a larger scale, and was the only means of obtaining considerable quantities of liquid air down to 1895. Attempts were made by others than Pictet to apply it to the liquefaction of hydrogen. But the critical temperature of hydrogen, above which no pressure can liquefy it, is so low that even air boiling into a vacuum at, say, -210° C., or solid nitrogen at -225° C., is not cold enough to cool it below its critical point. If an intermediate gas could have been found, with a critical point high enough to admit of its being condensed under high pressure at the lowest temperature of liquid air, and boiling under reduced pressure at a temperature below the critical point of hydrogen, the problem would have been solved. Nature having provided no such gas, Dewar tried to make one by mixing nitrogen and hydrogen, in the hope that, after the manner of oxygen and nitrogen in air, they would liquefy together. Olszewski made a similar attempt with a mixture of oxygen and hydrogen; but no one succeeded in liquefying hydrogen by the employment of vaporisation cooling, though intensified by cascading in four stages.

Meantime, another method of obtaining a cooling effect had been employed. Thomson and Rankine had shown theoretically in 1852, and Giffard practically in 1873, that if compressed gas be allowed to expand in a cylinder doing work against a piston, the work done externally is represented by a corresponding diminution of the heat-energy of the gas. Similarly, if an iron vessel containing highly compressed gas have the valve opened, the contained gas is forcibly driven out against the resistance due to the generation of a very high velocity. The work of driving it out against this resistance is at any moment being done by the expansion of that which remains inside the vessel, and this remaining gas is cooler in virtue of the work so done. This is the cooling of a gas by work-expansion. In 1877 Cailletet made use of this method to give the first definite practical proof that it was possible to liquefy oxygen, then known as a permanent gas. The vessel in which he had it enclosed under high pressure was a strong glass tube of small bore, which was surrounded by liquid sulphur dioxide or nitrous oxide to give the compressed oxygen a preliminary cooling. The opening of a water-valve then allowed the gas to do the work of driving some water forcibly through, and the gas, after this work-expansion, was so much colder that part of it was condensed into a visible, though evanescent, mist or vapour of oxygen. In 1884 Wróblewski and Olszewski applied the same method to hydrogen, using for preliminary cooling the lowest temperature of liquid air under reduced pressure, and obtained a similar result. Thus a combination of cooling by work-expansion with preliminary cooling by cascaded vaporisation succeeded in practically proving that hydrogen could be liquefied, though it was not possible by any such combination to keep, examine and work with liquid hydrogen.

But there is a third method of cooling a gas—that of free expansion. In the case of the iron vessel containing compressed gas, that gas which is at any moment expanding from the valve is found to be colder immediately after expansion than it was immediately before, though it has, in the act of expansion, done no tangible external work such as it does when expanding within the vessel or behind a piston. It has, however, displaced atmospheric air, given itself considerable residual momentum, and overcome the forces of intermolecular and intramolecular attraction. In virtue of this work done, it has undergone some cooling, the cooling of free expansion. This cooling from free expansion is much less for a given change of pressure than that from work-expansion, or that from vaporisation; so much so that Thomson and Joule had proposed no use for it, and great practical authorities, Siemens and Coleman, had declared that nothing could be accomplished by it—a judgment apparently confirmed by the abortive result of Piazzi Smyth's persevering efforts to utilise it. It is obvious, however, that if there were a method of refrigeration in which the cooling could be continually intensified by accumulation, this method would have a great advantage and would lead ultimately to lower temperatures than other methods which had the benefit of greater initial cooling. This proved to be the case with the method of free expansion. In 1894 Hampson proposed to intensify continually the cooling on this method by accumulating in the compressed gas to be expanded all, or nearly all, of the refrigeration produced by the free expansion of previous portions. This was to be done by letting the compressed gas expand through a nozzle or valve from one end of a long tube and making all the gas, when expanded, immediately return over the tube which it had previously traversed as compressed gas towards the expansion-valve. In the course of this return it cools the succeeding portions of compressed gas which are flowing past it inside the tube, so that as they pass to the expansion point they contain all the cooling which has been previously effected. Thus the compressed gas is continually expanding from a lower temperature than before, and is consequeutly reaching, with the added expansion-cooling, a lower temperature than had been reached by previous portions of expanded gas. This intensification goes on until the cooling is great enough to liquefy a small portion of the expanding gas. The losses in this system are due to imperfect interchange of temperature between the compressed and the expanded gas and to the penetration of external heat, so that its performance depends on the efficiency and compactness of the interchanger or counter-current accumulator. This method of obtaining intense refrigeration involves the combination of free expansion of gas (not liquid) with intensification by counter-current interchange. Hampson constructed and worked his apparatus in 1896, and in its present form it begins liquefying air in less than ten minutes without employing auxiliary refrigerants. A process involving substantially the same combination was invented at or near the same time by Linde, who, in 1895, succeeded in liquefying air with it in fifteen hours. His form of apparatus has since liquefied air in two hours, but requires auxiliary refrigeration in the form of ice and salt or a subsidiary ammonia machine.

The special advantage of the Hampson or Linde method for the liquefaction of hydrogen is that it can take gas at an initial temperature from two to three times as high as its critical temperature, and cool it progressively to the point at which it condenses continuously, without the assistance of any substance boiling below its critical temperature—a condition which had been the stumbling-block of the methods employed by Wróblewski, Olszewski and Dewar. With such an appliance available it would seem that the last difficulty in the way of liquefying hydrogen had been removed. Joule and Thomson, however, had observed that hydrogen, on free expansion, instead of being cooled, is actually heated a little. But they had also observed facts which showed how this difficulty could be overcome. The amount of cooling on free expansion varies with the expansion-temperature and with the nature of the gas. Firstly, as to temperature. The lower the initial temperature the greater the cooling for a given degree of expansion, the variation being inversely proportional to the square of the temperature on the absolute scale. Thus, for every atmosphere that the pressure falls in expansion, air at normal temperature is cooled about a quarter of a degree Centigrade. But expanding from three-quarters of that temperature, or $-56°$ C., it is cooled nearly twice as much, or half a degree, for each atmosphere that the pressure falls. And Thomson considered that, if allowed to expand from an initial temperature of 100° C., it would undergo no cooling at all. The differences of cooling for different substances point in the same direction. Joule and Thomson found that gases which are at a lower point in the scale of corresponding states show more cooling on free expansion than others. Thus oxygen, which is not so far above its critical point as nitrogen, shows more cooling; and carbonic acid, which is actually below its critical point, shows much more. It was a reasonable conclusion then that hydrogen also, if it were made a much less perfect gas by being cooled down to a temperature not much above its critical point, would undergo considerable cooling on free expansion. Early in 1896 Onnes calculated that if hydrogen were cooled to $-210°$ C. before free expansion it would be in the same position in the scale of corresponding states as oxygen expanding from $-20°$ C. Now oxygen expanding from $-20°$ is in a very favourable condition for cooling on free expansion, for it can be liquefied by that method from an initial temperature of $+30°$ C., and hydrogen can readily be cooled below $-200°$ C. by air boiling at low pressure.

In 1898 Dewar had an apparatus constructed to work on the principle above described, and succeeded in collecting hydrogen as a stable liquid, thus obtaining temperature which he subsequently estimated by platinum-resistance thermometer at $-238·4°$ C., or 34·6° A., by constant-volume hydrogen thermometer at $-253°$ C., or 20° A. Later, he boiled liquid hydrogen at low pressure and found it to be, like nitrogen and carbonic acid, one of the substances which readily freeze themselves by evaporation. In the solid hydrogen thus obtained he reached the lowest temperature known, which he estimated at from 13° to 15° A.—temperatures confirmed by his subsequent observations by helium thermometer.

Liquid hydrogen has already been turned to useful account in scientific work by Ramsay and Travers in their researches on the rare inactive gases of the atmosphere. For the purpose of obtaining pure neon by a process of fractional distillation, it was necessary to have so low a temperature that liquid hydrogen had to be employed as a cooling agent. To make this, Travers designed an apparatus on the plan described above, to work in combination with a Hampson air-liquefier which they had at their disposal. The plan involved the preliminary cooling of hydrogen by liquid air at low pressure and its further cooling by free expansion with intensification by counter-current interchange. The Dewar form of the apparatus appears, from such descriptions of it as have been published, to be on the same general plan. The Travers apparatus is fully described, with a drawing to scale, in a paper by its designer in the *Philosophical Magazine* for April 1901. For the present purpose a clearer idea of its working will be obtained from a simplified diagram of it, such as is here given. To avoid complexity, the insulation, the joints and many other details have been omitted.

The operation is as follows: hydrogen is compressed in a pump, the plungers of which are lubricated with water, to a pressure of about 200 atmospheres. The lubrication water and any hydrogen dissolved in it or blown off with it pass together from the water-separator by the tube T for further separation at low pressure in a chamber guarded by a water-seal, whence the gas returns by U and O to the gas-holder. The high-pressure gas from the compressor and a drying purifier passes by the tube A through a coil in the vessel B, containing solid carbonic acid in methylated spirit, by which the hydrogen is cooled to $-79°$ C. Thence it passes through the coil C in another vessel containing liquid air, and the temperature is thereby reduced to about $-185°$ C. In the next vessel lower it is reduced, in the coil D, to a temperature below $-200°$ C. by liquid air boiling at reduced pressure. The liquid air for this purpose is admitted, as required, by the valve E from the vessel above; and the low pressure is maintained in the vessel D by an exhaust-pump connected with it by the tube F and the passage R S. The compressed hydrogen at the temperature of low-pressure liquid air then passes through the coil K in the vessel P, forming the counter-current interchanger, and so reaches the expansion-valve M. It is in this lowest vessel that the operation takes place which has made the liquefaction of hydrogen possible. The vessel and coil K have been previously reduced to the temperature of low-pressure air in the following way. The vessel is connected with the exhaust-pump through the annular passage L and the tube F by opening the tap G and closing H. The tap Q at the bottom of the vessel having

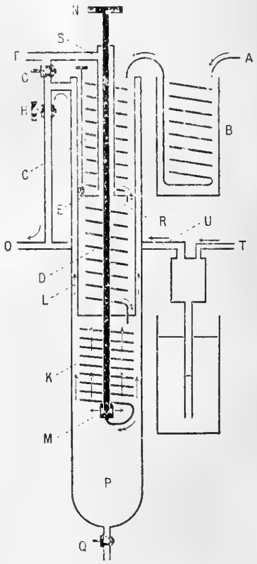


Fig. 1.—A, from compressor ⟶➤ high-pressure gas; M, expansion-valve ⟶, low-pressure gas; O, to gas-holder; F, to exhaust-pump; T, from water-separator of compressor.

been opened, a supply of liquid air is drawn up into the vessel by the suction of the exhaust-pump; and the tap being then closed, the exhaust pressure causes the liquid air to boil at a reduced temperature, cooling the vessel P, the coil K, and the compressed hydrogen within it to about $-205°$ C. The vessel is now cut off from the exhaust-pump by reversing the taps G and H, which remain in the position shown, and the remaining liquid air is drawn off again through Q, which is then closed. The valve M is now opened by turning the spindle controlled by the hand-wheel N, and the hydrogen at about $-205°$ C., issuing into the chamber P, is cooled by free expansion through, say, 10°, to $-215°$ C., and then returns by the passage L and the pipe O to the gasholder. But before doing so it begins the process of intensification by passing over the coil K and giving up to this coil and the high-pressure hydrogen within it the ten degrees of additional cooling below -205° C. which it had gained by expansion. Thus the high-pressure gas which succeeds it reaches the expansion-valve at -215° C., and expanding from a lower temperature gains by free expansion a greater amount of cooling, say 15°, so that it now passes away over the coil at -230° C. and cools to this temperature the compressed gas by which it is succeeded. This intensification proceeds until the cooling reaches the boiling point of hydrogen at the pressure obtaining in P. That pressure is practically atmospheric, since the vessel communicates with the gasholder, which is sealed by a few inches of water. Liquid hydrogen then collects in the lower part of the vessel P.

One of the results of liquefying hydrogen has been to show that helium is a still more volatile gas. It is possible, therefore, to reach a lower temperature than that of liquid—probably even than that of solid—hydrogen by applying to helium the same process of free expansion with intensification by counter-current interchange which has succeeded in liquefying hydrogen. But helium is an exceedingly rare gas, so that the cost of further advances will be very great. Moreover, the most volatile gas probably becomes solid and loses practically all vapour-tension at a temperature above the absolute zero, so that for the attainment of that interesting point no combination of the three methods of cooling above described will suffice. Some fourth system of pumping energy will have to be devised before any portion of matter can be absolutely deprived of heat, and it is for the discovery of this fourth method that onlookers interested in low temperature research are now waiting.

PROFESSOR TAIT.

IN the month of February, Prof. Tait, owing to a lingering illness, resigned the chair of natural philosophy in the University of Edinburgh. Since then the graver symptoms of his illness had somewhat abated, and it was hoped that he might live to enjoy some years of rest and relaxation.

This hope was disappointed by his sudden death on July 4, at Challenger Lodge, Wardie, whither he had been removed for change of air on the invitation of his friend and former pupil, Sir John Murray.

The end of his blameless life and brilliant career brings to many an irreparable gap in their circle of friendship, and to the University of Edinburgh the loss of her chief ornament. Of late years Tait had confined himself more and more to his class work, to the management of the affairs of the Royal Society of Edinburgh, and to the pursuit of his manifold scientific investigations. But, although his direct participation in University affairs diminished, his colleagues never lost the impression that a great man dwelt among them, and not one of them would have dreamed of taking action in a matter likely to interest Tait without considering his opinion. To those who knew him intimately, and therefore loved him, the coming years will never fill his place, although they may alleviate the sense of loss by weaving around it happy memories of flashes of his keen and rapid intellect, of the merry geniality and quaint eccentricity of his singularly beautiful character, and of his staunch, almost quixotic, devotion to an approved cause or to a friend.

Tait was in most senses an Edinburgh man. He was born at Dalkeith on April 28, 1831. His early education was obtained at the Dalkeith Grammar School, and at the Circus Place School in Edinburgh. Like his namesake, the late Archbishop of Canterbury, Tait was a distinguished pupil of the Edinburgh Academy; and loved to tell amusing stories of his mathematical master, Dr. Gloag, whose stern, eccentric character was one of his favourite recollections. At the University he studied for a session under Kelland and Forbes. The former became his colleague and lifelong friend, and he cherished the memory of the latter even in such insignificant matters as the details of class-certificates and class-examinations; and, when the priority or credit of Forbes's work was called in question, he defended him with a ferocious knight-errantry that surprised those who knew Tait little and seemed so characteristic and charming to those who knew him well.

Some of Tait's Academy schoolfellows are still alive, and they speak of him with a mixture of love and respect which shows that he must have been a leading figure among them. Clerk-Maxwell was his most intimate school and college friend, and the friendship thus begun continued to the end of Maxwell's life, absolutely undisturbed by the fact that the two were rival competitors for the Edinburgh chair in 1860. The two men were in truth the Damon and Pythias of British science. Each in his special way was strong in mathematics, both had intense love for physical science, and both were men of wide and varied culture. Each understood perfectly both the strong and the weak points of the other, and both were men of playful disposition and of absolute frankness and sincerity. Those who have occasionally seen letters that passed between them will readily agree that their correspondence should be preserved with a view to ultimate publication; for it would undoubtedly prove one of the most interesting scientific documents of the nineteenth century.

The promise of the two illustrious Edinburgh friends was amply fulfilled in Cambridge. Tait was senior wrangler and first Smith's Prizeman in 1852, being then twenty-one years of age, and Maxwell was second wrangler and first Smith's Prizeman, equal with Routh, in 1854. They were happy in their private tutor, William Hopkins, of whom Tait always spoke with the highest appreciation, and to whose tuition he attributed with characteristic generosity much of the mathematical skill which doubtless came to him by the grace of God. He often contrasted the method and spirit of Hopkins' teaching with the work of the modern coach; but in his depreciation of the latter he perhaps scarcely allowed enough for the brilliancy of Hopkins' pupil and the altered circumstances of the tutor of to-day.

Into the boisterous joviality of Cambridge undergraduate life in his time Tait entered fully, and one often envied the boyish zest with which in middle age he would recall the part he had taken in many a college prank at Peterhouse in his youth. He was, indeed, all his days a sympathiser with the frolics and the foibles of ordinary men, and his stately figure and the genial smile on his rugged, manly face will be as much missed on the green at St. Andrews and in the smoking room of the "Royal and Ancient" as it will be in the quadrangle of the University. Tait was a keen golfer, and for forty years his invariable recreation was an annual holiday at St. Andrews, which he spent mainly on the links. He watched with great delight the triumphal progress to the championship of his amiable son Freddy, and it was said, probably with truth, that Freddy's fame was dearer to him than his own scientific renown. There is little doubt that Freddy's untimely death in the South African war and the agonising weeks of suspense that preceded the final news of his fate hastened the onset of his father's last illness, and it is certain that it darkened the close of a singularly placid and happy life.

In 1854 Tait was appointed professor of mathematics in the Queen's College, Belfast, and there he became acquainted with Andrews the chemist, and through him with Rowan Hamilton the mathematician. These two men exercised a decisive influence on his future life, and, as was his way, he repaid them both with the tenderest regard and reverence. Andrews stimulated his love for well-directed physical research, and helped him to cultivate that marvellous power of clearly apprehending and plainly formulating both the facts and the theories of natural philosophy which was the greatest part of his genius as a physicist. Through the works and personal influence of Hamilton he was led to the study of quaternions—the source and inspiration of his most important contributions to pure mathematics.

In 1860 he was elected to the chair of natural philosophy in Edinburgh, which he was to hold for forty years with ever-increasing distinction. In that time a great army of students[1] has passed through his class room, and few have done so without carrying away with them the image of a great man and a notable teacher. A select number, not a few, have caught some of the original fire of their master and have gone abroad upon the earth to spread his ideas and practise his methods.

Of late years, mainly from want of funds, the laboratory equipment of Edinburgh University has been temporarily eclipsed by grander installations elsewhere; but it must never be forgotten that Tait was one of the first teachers in Great Britain to organise laboratory teaching for his students. Among his first "researchers" were a remarkable trio—Robert Louis Stevenson, William Robertson Smith and John Murray. No man but Tait could have drawn forth and brought together three men so highly distinguished, so utterly different. The popular estimates of the contributions of Murray and Stevenson to science would likely be correct; but it is probably not generally known that Robertson Smith made at least one important contribution to physical science, and was for a time Tait's assistant. He visited his old master regularly as long as he lived, and adored him, as everyone did, without exception, who had once come under his influence.

It appears to have been about the time of his appointment to the Edinburgh chair that Tait first became personally acquainted with Lord Kelvin. Kelvin (then William Thomson) was also a Peterhouse man, but had left Cambridge before Tait came up, and was already, independently and in conjunction with Joule, and concurrently with Rankine and Clausius, writing his classical memoirs on the theory of energy. The first edition of Tait and Steele's "Dynamics," published in 1856, does not, so far as a rapid examination could detect, contain either of the words *work* or *energy*. In its original form it was founded on Pratt's "Mechanical Philosophy," and written on the old-fashioned Cambridge lines, which knew not of Lagrange and Hamilton. Six years later it is on record[2] that in his introductory lecture Tait handled the notions of the "energetic" school with a freedom which bewildered his uninitiated hearers, and laid down the broad lines of a thoroughly modern course of natural philosophy. Probably, therefore, he had come under the influence of Joule and Kelvin before he became personally intimate with the latter. The conjunction with Kelvin produced the famous treatise on "Natural Philosophy," by Thomson and Tait, now familiarly known as T and T′. This wonderful book was published in 1867, and at once began to make a new era in mathematical physics. At first, owing to its highly condensed structure, its influence spread very slowly; but now it would be impossible to find an important treatise, or even a course of college lectures, on natural philosophy that does not show traces of its teaching. The work, it is true, is but a fragment, but the continuation is to be found in dozens of treatises written by men who have been nourished by the strong meat of its serried pages. The collaboration was so perfect that it is not easy to point out the parts due to Kelvin and to Tait.[3] During a somewhat intimate acquaintance, extending well over twenty years, the present writer never heard Tait drop a hint that would enable one to fix on any part of the great treatise as his special work. Its authors always spoke of it and quoted it in an oddly distant way, as if it had been the work of some third person. The two distinguished coadjutors were compelled, by diverging spheres of activity, to dissolve their partnership in T and T′; but, however divided their spheres, they were in scientific aim, as in friendship, undivided to the last.

Since the last paragraph was written, Lord Kelvin has favoured the writer with a note on Tait's early intimacy with himself, and on their collaboration in T and T′. This we reproduce verbatim for the readers of NATURE.

"I first became personally acquainted with Tait a short time before he was elected professor in Edinburgh; but, I believe, not before he became a candidate for the chair. It must have been either before his election or very soon after it that we entered on the project of a joint treatise on natural philosophy. He was then strongly impressed with the fundamental importance of Joule's work, and was full of vivid interest in all that he had learned from, and worked at with, Andrews. We incessantly talked over the mode of dealing with energy which we adopted in the book, and we went most cordially together in the whole affair. He gave me a free hand in respect to new names, and warmly welcomed nearly all of them.

"We have had a thirty-eight years' war over quaternions. He had been captivated by the originality and extraordinary beauty of Hamilton's genius in this respect, and had accepted, I believe, definitely from Hamilton to take charge of quaternions after his death, which he has most loyally executed. Times without number I offered to let quaternions into Thomson and Tait, if he could only show that in any case our work would be helped by their use. You will see that from beginning to end they were never introduced."

Tait's contributions to our text-book literature began with Tait and Steele's "Dynamics," already mentioned. His friend Steele (second wrangler and second Smith's Prizeman in his own year) died early, and wrote but a few chapters of the book. It was so much altered in successive editions that the retention of his name on the title-page became simply a pious tribute to the memory of a friend. The "Elements of Quaternions," begun in 1859, but, in deference to Hamilton, not published till 1867, went through three editions, and along with the "Introduction to Quaternions," by Kelland and Tait (1873), formed, and still forms, the best approach to the science of S, T and ∇. The "Sketch of Thermodynamics" (1868), originating in articles in the *North British Review* (1864), and Balfour Stewart's "Heat" (1866), were for long the only readily available source of information for English readers on the theory of energy, and both contributed powerfully to the growth of the "energetic" school of natural philosophy. "Recent Advances in Physical Science" (1876), a series of popular lectures for professional men, is one of the raciest of his books, and the most useful for the general reader. "Light" (1884), "Heat" (1884) and "Dynamics" (1895), republications of articles written for the "Encyclopædia Britannica," are all models of their kind, clear, forcible and concise, like everything he wrote. Those who wish to have an idea of how Tait taught should read "Properties of Matter," which embodies a considerable part of the course he usually gave to his elementary class.

Although Tait rarely spoke on matters relating to the Unseen, and in general avoided theological controversy, his intimate friends were well aware that he held decided views on such matters. The writer well recollects the grim humour of a Homeric battle at the Edinburgh Evening Club between him and Thomas Stevenson (father of Robert Louis), occasioned by the introduction into the conversation, by some malicious friend, of the

[1] The writer of an excellent notice in the *Scotsman* has estimated the number at about 10,000.

[2] See an admirable appreciation of Tait in the *Glasgow Herald*.

[3] This is almost the only point on which we differ from the writer of the *Scotsman* article.

subject of the Shorter Catechism. It was, therefore, no surprise to some when he and Balfour Stewart proved to be joint authors of "The Unseen Universe" (first printed privately in 1875). This remarkable book reflects the extraordinary width of Tait's knowledge and of his interest in things known and unknown; its success, so far as its immediate object was concerned, is best described by Tait himself in an obituary notice of Balfour Stewart.

"It has passed through many editions, and has experienced every variety of reception—from hearty welcome and approval in some quarters to the extremes of fierce denunciation, or of lofty scorn, in others. Whatever its merits or demerits, it has undoubtedly been successful in one of its main objects, viz. in showing how baseless is the common statement that 'Science is incompatible with Religion.' It calls attention to the simple fact, ignored by too many professed instructors of the public, that human science has its limits, and that there are realities with which it is altogether incompetent to deal."

Tait's scientific memoirs are being republished in three goodly volumes by the Pitt Press, two of which have already appeared. It is therefore unnecessary to do more than allude to the most important of them. The subjects range over pure and applied mathematics and experimental physics. The majority of the mathematical papers are written in the quaternion notation, and this has undoubtedly prevented some of them from becoming so well known as they deserve to be. We may mention specially two papers on Fresnel's wave surface (1859); a series of papers on the properties of "nabla" (∇), and on the linear and vector function, extending from 1867 to 1900; on the rotation of a rigid body about a fixed point (1868)—a paper of great power and elegance, which exhibits Tait's mathematical power at its best; on Green's and other allied theorems (1870), on orthogonal isothermal surfaces (1872); on knots (1877, 1884, 1885), a series of three papers suggested by the problem of the possible configurations of a Thomson vortex atom. In the three classical papers last named he virtually creates a new chapter in the geometria situs, and is brought into relation with the work of Listing, for whom he had the greatest respect. To this subject he returns again in two subsequent papers: a note on a theorem in geometry of position (1880), and on Listing's topologie (1884).

His first experimental work was on ozone, in collaboration with Andrews (from 1856 to 1860). He also began to work with the same distinguished investigator on the compression of gases, but this was interrupted by his removal to Edinburgh in 1860. His memoir on thermal and electric conductivity contains the result of an elaborate series of experiments extending over ten years. The original idea of the method was due to Forbes, but the complete theory and the difficult details are the work of Tait and his pupils. The memoir on mirage is a remarkably elegant and effective combination of experimental and mathematical methods, and is, perhaps, the best example of Tait's work as a natural philosopher. His investigation of the pressure errors of the *Challenger* thermometers was an intricate piece of experimental work extending over several years. It led him into the discussion of the compressibility of liquids, to which are devoted five memoirs (1893–1898). This investigation brought him into close relations with the French physicist Amagat, for whom he had a great regard. Much work is embodied in five papers (1886–1892) on the foundations of the kinetic theory of gases, in which he endeavours to analyse into their logically simplest elements the first principles of a difficult and much-debated subject. His interest in the game of golf produced three important papers on impact (1888–1892), and two on the path of a rotating spherical projectile. On this subject he also wrote a series of popular articles which were widely read and appreciated.

Besides his text-books and original memoirs, Tait contributed assiduously to the current scientific literature of his day. We may mention in particular his article "On Energy" in *Good Words* (1863); his memoirs of Hamilton (*North British Review*, 1866) and of Andrews (along with Crum Brown, 1888); his famous lecture "On Force" (British Association, 1876), so cleverly parodied in Maxwell's poem—

"Ye British asses who expect to hear
Ever some new thing, &c.";

his article "On the Teaching of Natural Philosophy" (*Contemporary Review*, 1878); his fine appreciation of Maxwell's scientific work (NATURE, vol. xxi. p. 317, February 5, 1880), and his various contributions to the ninth edition of the "Encyclopædia Britannica."

Limitations of time and space, and others besides, make it impossible to attempt here any appreciation of the relative importance of Tait's original contributions to the science of the Victorian age. For one thing, the sense of bereavement is too near to us to permit of the necessary historical abstraction. Nor is this the time to enlarge on the polemical discussions in which Tait took part. Ready to take a blow, he did not always spare his strength in giving one, and his opponents did not always relish his rough play. It may be doubted whether many of them carried for long any resulting bitterness; but undoubtedly some of them were led, temporarily at least, greatly to mistake his character. Personal contact with him at once dissipated any such misconception. To feel the magic of his personality to the full it was necessary to visit him in the little room at the back of his house, No. 38 George Square, Edinburgh, the Spartan simplicity of whose plain deal furniture and book-shelves, unpainted, unvarnished, ink-spotted, littered with books and pamphlets and with piles of manuscript bristling with quaternion symbols, was so finely in tune with the tall, rugged figure, the loud, hearty greeting and the radiant, welcoming smile of the kindly host. Ten minutes in that sanctum would have made a friend of his bitterest foe, and the conquest would have been mutual and permanent, for it seemed to be an axiom of Tait's that a man who had become his friend could sin no more. Thither came at various times Joule, Andrews, Kelvin, Stokes, v. Helmholtz, Rankine, Clerk-Maxwell, Balfour Stewart, Rowland, the Wiedemanns (father and son), Adams, Newcomb, Huggins, Newton, Lockyer, Hamilton (at least in the spirit), Cayley, Sylvester, Hermite, Cremona, Clifford, Klein, Bierens de Haan and many more, the majority, alas! now departed like their common friend. It has been the main part of our endeavour to indicate, faintly at least, some of the qualities that attracted and retained such a galaxy of friends; the most potent of all was doubtless the oldest, the simplest ground of liking —he was loved so well because he loved so much.

G. CHRYSTAL.

NOTES.

THE Hughes Bennett laboratory of experimental physiology, which has been added to the University of Edinburgh by Mrs. Cox as a memorial of the work of her father, Prof. J. Hughes Bennett, in connection with medical education, was formally handed over to the University on Saturday last. The addition comprises a large laboratory equipped with appliances for practical work in experimental physiology by individual students, and a small lecture theatre for class demonstrations. The memorial character of the new laboratory is indicated by a bronze bas relief representing Hughes Bennett, which has been executed by Mr. MacGillivray. This is fixed to one of the walls of the laboratory, with an inscription below it commemorating the fact that Hughes Bennett was the first teacher in

Scotland to apply the microscope to the clinical investigation of disease. At the opening ceremony on Saturday, Sir J. Burdon Sanderson, Bart., formerly a pupil of Bennett, delivered an address upon his life and work. Referring to the work to be done in the laboratory, he said, "The laboratory is intended for researches in experimental physiology, by which term was meant the application of the methods derived from physics and chemistry to the investigation of vital phenomena—*i.e.* to the processes which were peculiar to the living organisms. Bennett used to teach in the old days that the scientific method of study was always comparative. It consisted in comparing the unknown with the known, the more complicated phenomena of disease with the simpler ones of health, in bringing their imperfect understanding of vital processes into relation with the clearer notions of natural philosophy. It was thus that physiology, which was at first little more than an introductory study to that of medicine, had been built up into an independent branch of natural knowledge which has its own special aim, the elucidation of the nature of vital processes, but derived its methods of investigation from physics and chemistry. He was sure that all present would cordially join with him in wishing Prof. Schafer success in carrying out the noble purpose to which Mrs. Cox has devoted her munificent gift." Prof. J. G. McKendrick, who was an assistant of Bennett's thirty years ago, proposed a vote of thanks to Sir John Burdon Sanderson, and it was seconded by Sir John Batty Tuke. Sir William Muir, in closing the proceedings, expressed the indebtedness of the University to Mrs. Cox for her munificence.

We regret to see the announcement of the death of Miss E. A. Ormerod, whose studies of injurious insects for many years made her a distinguished authority on agricultural entomology. Miss Ormerod was seventy-four years of age.

The Paris correspondent of the *Times* announces the death of the eminent zoologist, Baron Henri de Lacaze Duthiers, at the age of eighty years. M. de Lacaze Duthiers began life as a medical student in Paris, and in 1854 became professor of zoology at Lille. After his appointment in 1862 to a mission in the Mediterranean, he wrote his famous book "Le Corail." Three years later he became professor of natural history at the Museum, and in 1868 was given a chair at the Sorbonne. In 1871 he succeeded M. Longet at the Academy of Sciences. His activity in the foundation of marine laboratories at Roscoff and at Banyuls-sur-Mer—institutions which were partially endowed by himself—was not the least of his contributions to science.

The council of the British Medical Association has awarded the Stewart prize to Dr. Patrick Manson, F.R.S. The prize was founded by the late Dr. A. P. Stewart, to be awarded biennially for the recognition of important work already done, or of researches instituted, and promising good results regarding the origin, spread and prevention of epidemic disease with a view to encourage the continuance of the same. It consists of an illuminated certificate and a cheque for 50*l.* The Scientific Grants Committee of the Association has allowed 350*l.* for scientific grants and 650*l.* for research scholarships. In the latter sum is included the separate scholarship known as the (200*l.*) Ernest Hart memorial scholarship. The total amount which has been spent in scientific research through this committee since its institution in 1874 is 15,998*l.*, independently of 1650*l.* granted to societies and bodies outside the Association.

In connection with the subject of the subjective lowering of musical pitch, Mr. Harding's theory referring to it (p. 103), and a suggestion made by Mr. E. C. Sherwood (p. 233), Mr. G. W. Hemming thinks the following experiment should be made by some one with the necessary instruments:—"Set siren A to middle C. Set siren B (say) half a tone lower. Sound A loud and B soft. Then by gradually varying the loudness of one of them a point should be reached at which they would appear *to the ear* as a unison. If this cannot be done, there must be some error in Mr. Harding's theory." Mr. Hemming's experiment would test Mr. Sherwood's point, but it does not seem to be able to settle the original statements. "These," writes Mr. Harding, "can easily be tested by means of *one* siren rotating on a table, the ear of the observer being alternately lowered towards, and raised from, the table (which intensifies by its resonance); a point will soon be found beyond which the sound appears flattened."

The *Revue générale des Sciences* for July 15 contains an interesting article by M. André Blondel on oscillographs. The principles of these instruments have already been described in Nature (vol. lxiii. p. 142), more particularly in reference to the various types of bifilar oscillographs worked out by Mr. Duddell. M. Blondel gives descriptions of the two types of instrument which he has himself perfected and used with such great success in his researches on the arc, namely a bifilar oscillograph similar to those of Mr. Duddell and an oscillograph in which the moving part consists of a ribbon of soft iron. In a comparison of the relative merits of the two different types, M. Blondel considers that the bifilar instrument is the more suitable for laboratory work on account of its great sensibility and accuracy, but that the soft iron type is to be preferred for industrial purposes as it is less fragile and more portable. None of M. Blondel's instruments seem, however, to be so compact as the small portable pattern recently shown by Mr. Duddell at the Institution of Electrical Engineers. An ingenious point in the design of M. Blondel's instruments is that the vibrating parts for different purposes—projection or research work—are all made to fit into the same magnet, thus allowing a simple and rapid change to be made according as the instrument is required for one purpose or the other. A continuation of the article, dealing with the application of oscillographs, is promised.

In *Symons's Meteorological Magazine* for this month, Mr. W. H. Dines contributes a paper on the fallacy of one of the explanations given in meteorological works as to the unexplained double diurnal barometer wave. The fallacy referred to lies in assuming that the inertia of the air can act like a containing vessel with only a small hole in it. If a barometer were placed in a sealed vessel, the changes in level of the mercury would follow the changes in the temperature of the air inside, but if a sudden change of temperature occurs in the lower layers of air, or a sudden increase of vapour tension, an oscillation of the barometer would occur, but with only an extremely small period, instead of lasting for hours. The author remarks that warmth reduces the height of the barometer, provided there is time for the upper part of the warmed column to roll off; but could a space be enclosed by a wall reaching to the upper limit of the air, no variations of temperature in the enclosed space could affect the barometer in the slightest degree. A mathematical statement of the question is given for any one who wishes to go into the matter. Dr. Mill gives a short note on the recent extreme heat in New York. The daily maxima do not appear to have exceeded 100° in the shade, but the night minima were frequently more than 80°, so that little difference of temperature was perceptible indoors between day and night. The humidity was also exceptionally high. It is said that special permission was given for people to sleep in the public parks. The worst part of the heat wave was from June 28 to July 4, during which time the deaths in the streets were so numerous that many bodies had to be buried without identification.

We have received from Mr. J. Elster and Mr. H. Geitel an account of their further experiments on electrical dispersion in closed air spaces (*Physikalische Zeitschrift*, No. 38). They, and Mr. C. T. R. Wilson of Cambridge, had previously arrived independently at the result that the air, notwithstanding the exclusion of all known influences that increase its electric conductibility, is by no means a perfect insulator, owing to the existence of ions, and that the rate of dissipation increased beyond its original amount in the course of a few days. A possible explanation of this behaviour seemed to be that dust-laden air is a worse conductor than air which is dust-free; it might be assumed that the increase of conductibility was due to a gradual self-purification of the air by the deposition of the dust-particles. To a certain extent this assumption is correct, but as it appeared doubtful that the dissipation was due solely to the air becoming dust-free, artificial means of purifying the air were tried. A minute description of the apparatus employed is contained in the article in question. The principal result arrived at is that the gradual increase of electric conductibility observed in closed air-spaces up to a certain limiting value can only be very partially due to the deposition of dust, or to variations of humidity. This is shown in a striking manner in the abnormally high conductibility of the air in cavities, and in cellars which have been closed for some time.

SIR W. J. L. WHARTON, K.C.B., the hydrographer, has presented his report upon the Admiralty surveys made during the year 1900, and it is published as a Blue Book. H.M. surveying vessels were all fully employed and good progress was made in each survey; 1167 miles of coast line were charted, and an area of 10,733 miles was sounded during the year. Dr. Fowler and an assistant were taken on board the *Research* in order to carry out, at the request of the Royal Society, zoological investigations in deep water about 150 miles southwestward of Ushant, the object of the observations being the determination of the vertical limits at which various forms of marine life exist. The surveying vessel, *Gladiator*, was taken to Larne Harbour, Ireland, with the view of ascertaining the truth of reports that the Maiden Rocks cause serious local magnetic disturbances. No such effect was, however, found. A chain of magnetic observations for variation was made at sea by the officers of H.M.S. *Rambler*, on the east coast of Africa off Durban, Beira, Mozambique, Zanzibar, Guardafui and the Arabian coast. The observations are said to show that considerable alteration has taken place of late years in the rate of change of the magnetic declination. During a voyage from Albany to Tasmania, H.M.S. *Penguin* obtained deep-sea soundings at regular intervals 130 miles apart. The greatest depth obtained was 3040 fathoms.

THE composition of alloys employed for bronze medals is referred to by Sir W. C. Roberts-Austen, K.C.B., in the report of the Deputy Master and Comptroller of the Royal Mint. He points out that of late years a change has gradually been effected in the metal used for striking medals which are known by the general name of bronze. Until comparatively recently such medals were invariably struck in copper, which subsequently received a superficial coating mainly consisting of oxide of copper, and the medal was said to be "bronzed." Such a "patina" was formerly imparted to the copper medal by heating it in contact with oxide of iron. The Japanese have long shown their remarkable skill as art-metal workers by employing a wet method, by the aid of which a wide range of shades of brown can be imparted to copper. The solutions are used boiling, and a variety of verdigris, known as "Rokusho," and sulphate of copper are their main constituents. The Japanese, moreover, are very successful in imparting a more or less translucent but permanent coating to the copper, which in fine examples of their art reveals the crystalline structure of the metal beneath the "patina." Sir William Roberts-Austen states that in the years 1897–98 more than 28,500 medals, in commemoration of the Jubilee of Her Majesty the late Queen, were so treated, and the specimens which have been preserved in the Mint show no diminution in the brilliancy of the tints which were originally imparted to them. Many European mints are following the Paris Mint in efforts to replace pure copper by copper alloyed with other metals. Analyses of coins of the reign of Hadrian and Trajan show that the alloys contained about 87 or 88 per cent. of copper and 7 to 11 per cent. of zinc, the remainder being made up of tin, lead, iron and silver, with traces of arsenic and antimony. Sir William Roberts-Austen remarks that modern medallists are working with alloys which resemble those from which the coins mentioned were struck, so that the medallist of to-day is returning to the ideas developed in ancient Rome.

A NEW rangefinder, invented by Prof. G. Forbes, F.R.S., was on view at the Bisley rifle meeting. The want of a rangefinder that is portable and workable, that has not more than two per cent. inaccuracy at 3000 yards, and that does not require a telescope so large as to require a stand, is much felt for infantry work, especially with maxims. All these conditions, says the *Times* correspondent at the meeting, are met by the one in question. It consists of a folding aluminium base, six feet in length, which can be folded in the middle and strapped across the back, and a field-glass carried in the usual fashion. The base is a square tube, hinged at the middle. Each half has at each end a doubly reflecting glass prism. The rays of light from a distant object strike the outer pair of these four prisms, are reflected at right angles along each tube, and are then reflected at the two middle prisms into the two telescopes of the binocular, which can be easily fixed to the centre of the base when in use in directions parallel to the original rays intercepted by the outer prisms. By the measurement of the angle between these rays the distance of the object looked at is determined. This angle is measured by two vertical wires, one in each telescope, seen by the two eyes. One of these wires is fixed, the other moved by a micrometer screw until the two wires appear as one at the same time that the object is seen distinctly. The instrument gives the distance, in the hands of an ordinary observer, at 3000 yards to within 60 yards, at 1500 yards to 15 yards. The 6 ft. base folds to 3 ft. 3 in. and weighs under 3 lb.

IN the *Revue générale des Sciences*, Dr. Guillaume, of the Bureau des poids et mesures, discusses the laws of radiation in reference to their application to incandescent mantles. Dr. Guillaume considers that the high intensity of the Auer light is due partly to the fact that the coefficient of radiation of the mantle is exceptionally high towards the blue end of the flame, partly to the temperature of the flame itself being, as the author shows, higher than has been commonly supposed, and partly to the density of the radiating substance being largely in excess of that of the carbon in an ordinary combustion flame. The high temperature of the mantle is probably attributable to the fact that its coefficient of radiation decreases rapidly towards the red end and infra-red of the spectrum, so that the total radiation is relatively small in comparison with the radiation of rays of short wave-length. Dr. Guillaume quotes the work of Messrs. Le Chatelier and Boudouard, and suggests that the coefficient of radiation of the mantles for infra-red rays presents an interesting field of study. It seems probable that as the wave-length increases, the coefficient may decrease to a minimum and may increase again in a region considerably distant from the visible spectrum. The substances used by von Welsbach thus exhibit gaps in an easily explored region of their emission-spectrum, and we may expect to obtain, with little difficulty, results differing considerably from those furnished by the study of substances whose radiation is more nearly uniform.

THE skin of the okapi, the new mammal discovered by Sir Harry Johnston in the Semliki Forest between Lakes Albert and Albert Edward, has been mounted for the Natural History branch of the British Museum by Mr. Rowland Ward, of Piccadilly. For a time it will be exhibited in the North Hall, among the domesticated animals, but will eventually be placed alongside its nearest living relatives, the giraffes, in the lower mammal gallery. The skin and two skulls were recently exhibited by the Director of the Museum at an evening meeting of the Zoological Society, on which occasion the name Okapia was proposed for this very remarkable mammal, the specific title *johnstoni*, previously suggested by Mr. Sclater on the evidence of two fragments of skin, being adopted. As now mounted, the okapi presents a considerable resemblance in form to a small, short-limbed and short-necked giraffe, although furnished with the large ears characteristic of all forest-dwelling animals, and with an absolutely peculiar type of coloration. No such important discovery has occurred since the giant panda (Ælluropus) was made known to the scientific world in the 'sixties of last century. Prof. Ray Lankester's description of this most interesting animal will be anxiously awaited by all naturalists.

WITH no less than seven reports and other technical documents before him, the writer of the article on the "Decay of our Sea Fisheries" in the July issue of the *Quarterly Review* takes a very serious, not to say pessimistic, view of the situation, and deplores the lack of interest in the fishing industry exhibited by Parliament. It is urged that, with far larger interests at stake, we spend much less money on inquiries connected with our fish-supply than other nations, and that the case for interference, based on the falling-off in the yield of inshore-grounds, is fully established. In this respect, indeed, we are suffering from an improvidence which would have been absolutely fatal in other industries; and the one excuse that can be made for legislative inactivity is that our knowledge of the life-history of our food-fishes is at present far too incomplete to permit of the drawing-up of really effectual regulations and amendments. Trawling as now practised is unhesitatingly condemned; while the importance of returning to the sea the spawn of newly-caught fish is strongly urged. There is, however, another aspect of the subject which has received too little attention. This is the great increase which, owing to protection, has of late years taken place in the numbers of our sea-birds. "No one," writes the author, "who has any sense of fairness blames the trout-hatcher for dealing summarily with the herons, otters, chub, pike and eels that invade his stews; and, if it becomes clear that there are no longer fish enough for both ourselves and the cormorants, it may be in like manner necessary to decide that charity shall begin, and end, at home." It may be added that attention is drawn to the value and importance of the researches carried on by the Liverpool Marine Biological Association and kindred bodies.

IN their Report for the year 1900 the executive committee announce that the New York Zoological Society is in a much more satisfactory financial position than it has ever been before, mainly owing to the liberality of the city. It is felt, however, that the Society does not receive adequate support from private citizens, and strenuous efforts are being made to raise the number of members to 3000, the total at the commencement of the present year being just short of 1000. The most important feature in the Report is an illustrated article by Mr. W. T. Hornaday on the wild sheep of America, the main object of this communication being the description of a hitherto unrecognised type inhabiting part of the Yukon valley. For this animal the name *Ovis fannini* is proposed. According to the illustration, it appears nearly allied to the white Alaskan bighorn, but has a large grey saddle on the back.

WE have received from the director of the Missouri Botanical Garden an elaborate paper on garden beans, by Mr. H. C. Irish. It deals with the species cultivated in America of the genera Phaseolus, Dolichos, Vigna, Glycine, and Vicia, and with their very numerous cultivated varieties, which are described in detail. Like so many of our cultivated fruits and vegetables, the scarlet runner and the kidney bean are unknown in the wild state. The broad bean is stated to be a native of Africa, and to be one of the oldest vegetables in cultivation. De Candolle says that it was cultivated in Europe in prehistoric times. The ten plates illustrate the very great variety in the seeds of the same species produced under cultivation.

IN the *Proceedings* of the Royal Academy of Sciences of Amsterdam, Dr. W. Burck has an interesting note respecting a possible provision of nature for preventing hybridisation in plants. He finds from experiment that the pollen-grains of different species vary very greatly in their sensitiveness to the action of the same chemical substance. Thus with some plants a very small quantity of lævulose greatly promotes the emission of the pollen-tubes, while with others it causes the pollen-grains to burst. Saccharose and dextrose have not the same effect as lævulose. He suggests that there may be present in the stigmatic secretion, not only substances which promote the emission of the pollen-tubes in that particular species, but also substances which act injuriously on the pollen of foreign species.

THE interesting discovery by Baron Toll of buried glaciers from the Glacial period, covered with more recent Post-Glacial deposits containing branches and roots of *Alnus fruticosa*, under the 74th degree of latitude, on the Great Lyakhoff Island of New Siberia, has already been mentioned several times in these columns. We have now received the thirty-second volume of the "Memoirs" (*Zapiski*) of the Russian Geographical Society, the first fascicule of which contains Baron Toll's memoir in full, with several interesting photographs. Three of these represent cliffs of glaciers ("fossil glaciers," as Baron Toll describes them), which are masses of ice, not of river ice, or of ice formed in clefts, but undoubtedly of a glacial ice, dating from the Glacial period, and covered with more recent layers of soil; while two other photographs represent layers of soil containing remains of *Alnus fruticosa* and a species of *Salix* deposited above the ice. The branches and the roots of the former are well seen on the photograph, while the catkins which were found by Baron Toll show that these trees, which now do not spread beyond 70° N. lat., grew on the New Siberian islands during the post-Glacial period. As to the mammoth, the rhinoceros and other extinct mammals, it seems impossible, since the researches of Fr. Schmidt, Tcherskiy, Bunge and Toll, not to accept the last author's conclusion, namely: "The mammoths and the other contemporary mammals lived on the spots where we now find their relics; they died out owing to a change in the physico-geographical conditions of the region. The bodies of these mammals, which have not died in consequence of some sudden catastrophe, were deposited in a cold region, partly on river terraces, and partly on the shores of lakes and on the surfaces of the glaciers, and there they were gradually buried in loam. They have been preserved in the same way as have been preserved the masses of ice underneath, owing to a permanent and perhaps increasing cold."

THOSE who are interested in the local antiquities, church and domestic architecture, folklore and antiquarian odds and ends of the counties of London, Middlesex, Essex, Herts, Bucks, Berks, Surrey and Kent, cannot do better than read *The Home Counties Magazine*, in which a number of brightly-written and well-illustrated articles on these various topics will be found.

THE Scottish archæologists should be happy, as they have a very useful bone of contention in the age of the crannog recently discovered at Dumbuck in the estuary of the Clyde. The Rev.

H. J. Dukinfield Astley warmly asserts its Neolithic origin and attacks Dr. Robert Munro for doubting this view. The weighty arguments of Dr. Munro are parried by Mr. Andrew Lang in his characteristic manner. Those who care to see the present position of this pretty quarrel should consult the current number of the *Reliquary and Illustrated Archaeologist*. Doubtless the problem will be threshed out in Section H of the British Association at the meeting in Glasgow in September next.

THE "Picts' houses" of Scotland are a perennial source of discussion to antiquaries, and Mr. David MacRitchie, who has long studied the Pictish question problem, describes in the *Reliquary and Illustrated Archaeologist* (vol. vii. 1901, p. 89) a series of interesting complicated bee-hive huts round which earth has been heaped. Mr. MacRitchie suggests that the series is as follows:—(1) The primitive subterranean "Picts' houses," consisting of one or more chambers and reached by a low narrow gallery. (2) Circular buildings with several chambers round a central one, the walls rising to a height of 12 to 15 feet and culminating in a "bee-hive" roof. (3) Brochs or forts, similar in ground plan to the last, rising as ring-like towers, with staircases in the walls and the central area unroofed.

THE May number of the *Physical Review* contains a good portrait of the late Prof. Fitzgerald, reproduced by photogravure. Dr. Larmor contributes an appreciative notice of the life and work of the lamented investigator, whose death all men of science sincerely deplore.

Feilden's Magazine will celebrate its second anniversary on the first of next month. During its short life it has shown what a good engineering magazine can be, and has maintained a high standard both in its first-class illustrations and in its text, which has been graphic and well up to date. On this account we are glad to express the wish that its future may be long and prosperous.

THE fifth part of "A Manual of Surgical Treatment," by Drs. W. Watson Cheyne, F.R.S. and F. F. Burghard, has been published by Messrs. Longmans, Green and Co. The subject is the treatment of the surgical affections of the head, face, jaws, lips, larynx and trachea, and one of the main divisions is on the intrinsic diseases of the nose, ear and larynx, by Dr. H. Lambert Lack. Dr. A. Whitfield gives an account of the method of removing superfluous hairs by electrolysis. The negative electrode from a battery of about five Leclanché cells is connected with a needle which is introduced into the neck of the hair follicle. The patient is then instructed to grasp firmly the positive electrode, and after a few seconds bubbles of hydrogen can be seen issuing from the mouth of the follicle. Shortly afterwards the needle is withdrawn, and after a moment or two the hair may be pulled out very easily. If the operation has been successful, Dr. Whitfield says that the hair will slide out of the follicle without offering the slightest resistance, and will bring the inner root-sheath with it. About forty hairs can, on the average, be taken out at one sitting.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, presented by Mrs. Morrell; a Lion (*Felis leo*, ♂) bred in Ireland, presented by Mr. Rowland Ward; an Alligator (*Alligator mississippiensis*) from Southern North America, presented by Mr. W. S. Foster; four Crossed Snakes (*Psammophis crucifer*), a Rough-keeled Snake (*Dasypeltis scabra*), two Rufescent Snakes (*Leptodira hotamboeia*), five Rhomb-marked Snakes (*Trimerorhinus rhombeatus*) from South Africa, presented by Mr. A. W. Guthrie; five Red-headed Weaver-birds (*Foudia madagascariensis*) from Madagascar, two Yellow-rumped Seed-eaters (*Crithagra sulphurata*) from South Africa, six Waxbills (*Estrelda cinerea*) from West Africa, two Nutmeg Birds (*Munia punctularia*) from India, presented by Mr. E. S. Foot; two Antillean Boas (*Boa diviniloqua*) from St. Lucia, presented by Mr. Walter Graham; an Algerian Skink (*Eumeces algeriensis*) from North Africa, presented by the Rev. F. Jervis-Smith, F.R.S.; two Peba Armadillos (*Tatusia peba*), three Brazilian Tortoises (*Testudo tabulata*), a Blue and Yellow Macaw (*Ara ararauna*) from South America, a Short-billed Toucan (*Ramphastos brevicarinatus*) from Central America, a Reticulated Python (*Python reticulatus*) from the East Indies, six Spiny-tailed Mastigures (*Uromastix acanthinurus*), three Grey Monitors (*Varanus griseus*) from North Africa, deposited; a Lion (*Felis leo*, ♂) bred in Ireland, received in exchange; two Crested Screamers (*Chauna cristata*) from Buenos Ayres, two Hoopoes (*Upupa epops*), European, a White-fronted Amazon (*Chrysotis leucocephala*) from Cuba, two Red Under-winged Doves (*Leptoptila rufaxilla*) from Guiana, purchased.

OUR ASTRONOMICAL COLUMN.

THE TOTAL SOLAR ECLIPSE, MAY 18, 1901.—Since the provisional telegraphic reports immediately after the eclipse there has been little further information as to the exact procedure of the various parties, but an article in the *Times* of July 20, 1901, gives a more comprehensive series of particulars.

Considering the adverse meteorological conditions, the observations in general must be classed as successful, as out of the fifteen stations occupied along the line of totality, determinations of some kind were made at thirteen places. In respect to the special investigations based on the unusually long duration of totality, however, the results are practically useless. Chief among these unsuccessful attempts were the large scale photographs of corona by Prof. Barnard, the spectroscopic determination of the rotation of the corona by Messrs. Newall, Wilterdinck and Baume Pluvinel, and the determination of heat radiation from corona by Dr. Abbott and Prof. Julius.

The photographs of the region round the sun for recording stars, &c., to be used in searching for possible intramercurial planet were more successful, good results being obtained by Prof. Perrine at Padang and Mr. Dyson at Auer Gadang.

The polariscopic investigations were only partly successful; visual observations were secured by Prof. Julius, and a series of photographs obtained by Mr. Newall with a Savart camera.

In the case of the chromospheric spectrum, several observers have secured more or less successful photographs. At Fort de Kock Dr. Humphreys has obtained good spectra of the lower chromosphere, using a concave grating, the whole blue and violet range of spectrum being on a film two feet long.

Mr. Newall, assisted by Lieut. Briggs, used an objective plane grating and obtained a series of spectra with high dispersion over a small range.

Dr. Mitchell also obtained a valuable series of spectra of the flash by means of a grating spectroscope.

Good series of photographs with prismatic cameras were obtained by the Dutch party at Fort de Kock, M. de la Baume Pluvinel, M. Donitch, and also by Mr. Maunder at Mauritius.

Numerous photographs of the corona and surroundings were obtained with various forms of cameras, but it is improbable that any of these taken in Sumatra will show any considerable extension of the streamers, and reliance will have to be made in this branch upon the photographs taken under the more favourable conditions at Mauritius. In Sumatra, series of large scale pictures were obtained with 40-feet lenses by Prof. Nyland, Mr. Perrine and Dr. Humphreys. Prof. Todd failed to even see the corona at Singkep on account of heavy clouds.

From an examination of the plates it is stated that they show a remarkable feature indicating a huge local storm in the eastern equatorial regions, and several bright arches apparently related to marked prominences, especially in the S.E. quadrant.

The duration of totality again appears to have been considerably different from the computed ephemeris time, the observed time in most cases being *shorter*. The Dutch astronomers at Painan report it about eleven seconds, and Mr. Dyson about nine seconds shorter than the almanac duration. Other observers, however, including Prof. Burton and the Fort de Kock party, appear to have found the time of totality longer than was predicted.

A noticeable feature of this eclipse has been the misleading effect of meteorological statistics as influencing the observers' choice of sites for their stations. The eclipse was observed under almost perfect conditions from Padang Pandjang, which is regarded as the rainiest and cloudiest region in Sumatra, while those who camped in the old Solok Fort were the least favoured on the entire coast.

THE TWELVE MOVEMENTS OF THE EARTH.—In the *Bulletin de la Soc. Ast. de France* (1901, pp. 262–266), M. Flammarion gives an interesting review of the various movements by which the terrestrial sphere is known to be affected at the present time. These are due to, or consist of, the following phenomena :—

(1) Rotation, having a period of 24 hours.
(2) Revolution, having a period of 365¼ days.
(3) Precession, having a period of 25,765 years.
(4) Luni-solar gravitation, having a period of 28 days.
(5) Nutation, having a period of 18⅔ years.
(6) Variation of obliquity of ecliptic, about 47″ arc in 100 years.
(7) Variation of eccentricity of orbit.
(8) Change of line of apsides, period about 21,000 years.
(9) Planetary perturbations.
(10) Change of centre of gravity of whole solar system.
(11) General translation of solar system in space.
(12) Latitude variation with several degrees of periodicity.

NEW NEBULÆ.—In the *Comptes rendus* (vol. cxxxiii. pp. 26–28 and 86–88), M. G. Bigourdan gives two further lists of new nebulæ discovered with the west equatorial at the Paris Observatory. The first paper deals with twenty-one objects, observed during the period 1897–1899, copious notes and comparisons with the N.G.C. being appended.

The second list contains similar information regarding nineteen nebulæ observed between 1884 and 1898.

THE SUPPRESSION OF TUBERCULOSIS.[1]

THE task with which this Congress will have to busy itself is one of the most difficult, but it is also one in which labour is most sure of its reward.

I need not point again to the innumerable victims tuberculosis annually claims in all countries, or to the boundless misery it brings on the families it attacks. You all know that there is no disease which inflicts such deep wounds on mankind as this. All the greater, however, would be the general joy and satisfaction if the efforts that are being made to rid mankind of this enemy, which consumes its inmost marrow, were crowned with success.

There are many, indeed, who doubt the possibility or successfully combating this disease, which has existed for thousands of years, and has spread all over the world. This is by no means my opinion. This is a conflict into which we may enter with a surely founded prospect of success, and I will tell you the reasons on which I base this conviction.

Only a few decades ago the real nature of tuberculosis was unknown to us; it was regarded as a consequence, as the expression, so to speak, of social misery, and, as this supposed cause could not be got rid of by simple means, people relied on the probable gradual improvement of social conditions, and did nothing. All this is altered now. We know that social misery does indeed go far to foster tuberculosis, but the real cause of the disease is a parasite—that is, a visible and palpable enemy, which we can pursue and annihilate, just as we can pursue and annihilate other parasitic enemies of mankind.

Strictly speaking, the fact that tuberculosis is a preventible disease ought to have become clear as soon as the tubercle-bacillus was discovered, and the properties of this parasite and the manner of its transmission became known. I may add that I, for my part, was aware of the full significance of this discovery from the first, and so will everybody have been who had convinced himself of the causal relation between tuberculosis and the tubercle-bacillus. But the strength of a small number of medical men was inadequate to the conflict with a disease so deeply rooted in our habits and customs. Such a conflict requires the cooperation of many, if possible of all, medical men, shoulder to shoulder with the State and the whole population; but now the moment when such cooperation is possible seems to have come. I suppose there is hardly any medical man now who denies the parasitic nature of tuberculosis, and among the non-medical public, too, the knowledge of the nature of the disease has been widely propagated.

[1] Paper on "The Combating of Tuberculosis in the Light of the Experience that has been gained in the Successful Combating of other Infectious Diseases," by Prof. Robert Koch, read at the British Congress on Tuberculosis, July 23.

Another favourable circumstance is that success has recently been achieved in the combating of several parasitic diseases, and that we have learned from these examples how the conflict with pestilences is to be carried on.

The most important lesson we have learned from the said experience is that it is a great blunder to treat pestilences uniformly. This was done in former times; no matter whether the pestilence in question was cholera, plague, or leprosy: isolation, quarantine, useless disinfection were always resorted to. But now we know that every disease must be treated according to its own special individuality, and that the measures to be taken against it must be most accurately adapted to its special nature, to its etiology. We are entitled to hope for success in combating tuberculosis only if we keep this lesson constantly in view. As so extremely much depends just on this point, I shall take the liberty to illustrate it by several examples.

The pestilence which is at this moment in the foreground of interest, the bubonic plague, may be instructive to us in several respects.

People used to act upon the conviction that a plague patient was in the highest degree a centre of infection, and that the disease was transmitted only by plague patients and their belongings. Even the most recent international agreements are based on this conviction. Although, as compared with formerly, we now have the great advantage that we can, with the aid of the microscope and of experiments on animals, recognise every case of plague with absolute certainty, and although the prescribed inspection of ships, quarantine, the isolation of patients, the disinfection of infected dwellings and ships are carried out with the utmost care, the plague has, nevertheless, been transmitted everywhere, and has in not a few places assumed grave dimensions. Why this has happened we know very well, owing to the experience quite recently gained as to the manner in which the plague is transmitted. It has been discovered that only those plague patients that suffer from plague-pneumonia—a condition which is fortunately infrequent—are centres of infection, and that the real transmitters of the plague are the rats. There is no longer any doubt that, in by far the majority of the cases in which the plague has been transmitted by ocean traffic, the transmission took place by means of plague among the ship rats. It has also been found that, wherever the rats were intentionally or unintentionally exterminated, the plague rapidly disappeared; whereas at other places, where too little attention had been paid to the rat plague, the pestilence continued. This connection between the human plague and the rat plague was totally unknown before, so that no blame attaches to those who devised the measures now in force against the plague if the said measures have proved unavailing. It is high time, however, that this enlarged knowledge of the etiology of the plague be utilised in international as well as in other traffic. As the human plague is so dependent on the rat plague, it is intelligible that protective inoculation and the application of antitoxic serum have had so little effect. A certain number of human beings may have been saved from the disease by that, but the general spread of the pestilence has not been hindered in the least.

With cholera the case is essentially different; it may, under certain circumstances, be transmitted directly from human beings to other human beings, but its main and most dangerous propagator is water, and therefore, in the combating of cholera, water is the first thing to be considered. In Germany, where this principle has been acted on, we have succeeded for four years in regularly exterminating the pestilence (which was introduced again and again from the infected neighbouring countries) without any obstruction of traffic.

Hydrophobia, too, is not void of instruction for us. Against this disease the so-called protective inoculation proper has proved eminently effective as a means of preventing the outbreak of the disease in persons already infected, but, of course, such a measure can do nothing to prevent infection itself. The only real way of combating this pestilence is by compulsory muzzling. In this matter also we have had the most satisfactory experience in Germany, but have at the same time seen that the total extermination of the pestilence can be achieved only by international measures, because hydrophobia, which can be very easily and rapidly suppressed, is always introduced again year after year from the neighbouring countries.

Permit me to mention only one other disease, because it is etiologically very closely akin to tuberculosis, and we can learn not a little for the furtherance of our aims from its successful combating. I mean leprosy. It is caused by a parasite which greatly resembles the tubercle-bacillus. Just like tuberculosis, it does not break out till long after infection, and its course is almost slower. It is transmitted only from person to person, but only when they come into close contact, as in small dwellings and bedrooms. In this disease, accordingly, immediate transmission plays the main part: transmission by animals, water, or the like is out of the question. The combative measures, accordingly, must be directed against this close intercourse between the sick and the healthy. The only way to prevent this intercourse is to isolate the patients. This was most rigorously done in the Middle Ages by means of numerous leper-houses, and the consequence was that leprosy, which had spread to an alarming extent, was completely stamped out in Central Europe. The same method has been adopted quite recently in Norway, where the segregation of lepers has been ordered by a special law. But it is extremely interesting to see how this law is carried out. It has been found that it is not at all necessary to execute it strictly, for the segregation of only the worst cases, and even of only a part of these, sufficed to produce a diminution of leprosy. Only so many infectious cases had to be sent to the leper-houses that the number of fresh cases kept regularly diminishing from year to year. Consequently the stamping-out of the disease has lasted much longer than it would have lasted if every leper had been inexorably consigned to a leper-house, as in the Middle Ages; but in this way, too, the same purpose is gained, slowly, indeed, but without any harshness.

These examples may suffice to show what I am driving at, which is to point out that, in combating pestilences, we must strike at the root of the evil, and must not squander force in subordinate ineffective measures. Now the question is whether what has hitherto been done, and what is about to be done, against tuberculosis really strikes at the root of tuberculosis, so that it must sooner or later die.

In order to answer this question it is necessary first and foremost to inquire how infection takes place in tuberculosis. Of course, I presuppose that we understand by tuberculosis only those morbid conditions which are caused by the tubercle-bacillus.

In by far the majority of cases of tuberculosis the disease has its seat in the lungs, and has also begun there. From this fact it is justly concluded that the germs of the disease, *i.e.* the tubercle-bacilli, must have got into the lungs by inhalation. As to the question where the inhaled tubercle-bacilli have come from, there is also no doubt. On the contrary, we know with certainty that they get into the air with the sputum of consumptive patients. This sputum, especially in advanced stages of the disease, almost always contains tubercle-bacilli, sometimes in incredible quantities. By coughing, and even speaking, it is flung into the air in little drops, *i.e.* in a moist condition, and can at once infect persons who happen to be near the coughers. But then it may also be pulverised when dried, in the linen or on the floor for instance, and get into the air in the form of dust.

In this manner a complete circle, a so-called *circulus vitiosus*, has been formed for the process of infection, from the diseased lung, which produces phlegm and pus containing tubercle-bacilli, to the formation of moist and dry particles (which, in virtue of their smallness, can keep floating a good while in the air), and finally to new infection, if particles penetrate with the air into a healthy lung and originate the disease anew. But the tubercle-bacilli may get to other organs of the body in the same way, and thus originate other forms of tuberculosis. This, however, is a considerably rarer case. The sputum of consumptive people, then, is to be regarded as the main source of the infection of tuberculosis. On this point, I suppose, all are agreed. The question now arises whether there are not other sources too, copious enough to demand consideration in the combating of tuberculosis.

Great importance used to be attached to the hereditary transmission of tuberculosis. Now, however, it has been demonstrated by thorough investigation that, though hereditary tuberculosis is not absolutely non-existent, it is nevertheless extremely rare, and we are at liberty, in considering our practical measures, to leave this form of origination entirely out of account.

But another possibility of tubercular infection exists, as is generally assumed, in the transmission of the germs of the disease from tubercular animals to man. This manner of infection is generally regarded nowadays as proved, and as so frequent that it is even looked upon by not a few as the most important, and the most rigorous measures are demanded against it. In this Congress also the discussion of the danger with which the tuberculosis of animals threatens man will play an important part. Now, as my investigations have led me to form an opinion deviating from that which is generally accepted, I beg your permission, in consideration of the great importance of this question, to discuss it a little more thoroughly.

Genuine tuberculosis has hitherto been observed in almost all domestic animals, and most frequently in poultry and cattle. The tuberculosis of poultry, however, differs so much from human tuberculosis that we may leave it out of account as a possible source of infection for man. So, strictly speaking, the only kind of animal tuberculosis remaining to be considered is the tuberculosis of cattle, which, if really transferable to man, would indeed have frequent opportunities of infecting human beings through the drinking of the milk and the eating of the flesh of diseased animals.

Even in my first circumstantial publication on the etiology of tuberculosis I expressed myself regarding the identity of human tuberculosis and bovine tuberculosis with reserve. Proved facts which would have enabled me sharply to distinguish these two forms of the disease were not then at my disposal, but sure proofs of their absolute identity were equally undiscoverable, and I therefore had to leave this question undecided. In order to decide it, I have repeatedly resumed the investigations relating to it, but so long as I experimented on small animals, such as rabbits and guinea-pigs, I failed to arrive at any satisfactory result, though indications which rendered the difference of the two forms of tuberculosis probable were not wanting. Not till the complaisance of the Ministry of Agriculture enabled me to experiment on cattle, the only animals really suitable for these investigations, did I arrive at absolutely conclusive results. Of the experiments which I have carried out during the last two years along with Prof. Schültz, of the Veterinary College in Berlin, I will tell you briefly some of the most important.

A number of young cattle which had stood the tuberculin test, and might therefore be regarded as free from tuberculosis, were infected in various ways with pure cultures of tubercle-bacilli taken from cases of human tuberculosis; some of them got the tubercular sputum of consumptive patients direct. In some cases the tubercle-bacilli or the sputum were injected under the skin, in others into the peritoneal cavity, in others into the jugular vein. Six animals were fed with tubercular sputum almost daily for seven or eight months; four repeatedly inhaled great quantities of bacilli, which were distributed in water and scattered with it in the form of spray. None of these cattle (there were nineteen of them) showed any symptoms of disease, and they gained considerably in weight. From six to eight months after the beginning of the experiments they were killed. In their internal organs not a trace of tuberculosis was found. Only at the places where the injections had been made small suppurative foci had formed, in which few tubercle-bacilli could be found. This is exactly what one finds when one injects dead tubercle-bacilli under the skin of animals liable to contagion. So the animals we experimented on were affected by the living bacilli of human tuberculosis exactly as they would have been by dead ones; they were absolutely insusceptible to them.

The result was utterly different, however, when the same experiment was made on cattle free from tuberculosis with tubercle-bacilli that came from the lungs of an animal suffering from bovine tuberculosis. After an incubation period of about a week the severest tubercular disorders of the internal organs broke out in all the affected animals. It was all one whether the infecting matter had been injected only under the skin or into the peritoneal cavity or the vascular system. High fever set in, and the animals became weak and lean; some of them died after a month and a half to two months, others were killed in a miserably sick condition after three months. After death extensive tubercular infiltrations were found at the place where the injections had been made, and in the neighbouring lymphatic glands, and also far advanced alterations of the internal organs, especially the lungs and the spleen. In the cases in which the injections had been made into the peritoneal cavity the tubercular growths which are so characteristic of bovine tuberculosis were found on the omentum and peritoneum. In short, the cattle proved just as susceptible to infection by the bacillus of bovine tuberculosis as they had proved insusceptible to infection by the bacillus of human tuberculosis. I wish only to add that preparations of the organs of the cattle which were artificially infected with bovine tuberculosis in these experiments are exhibited in the Museum of Pathology and Bacteriology.

An almost equally striking distinction between human and bovine tuberculosis was brought to light by a feeding experiment with swine. Six young swine were fed daily for three months with the tubercular sputum of consumptive patients. Six other swine received bacilli of bovine tuberculosis with their food daily for the same period. The animals that were fed with sputum remained healthy and grew lustily, whereas those that were fed with the bacilli of bovine tuberculosis soon became sickly, were stunted in their growth, and half of them died. After three months and a half the surviving swine were all killed and examined. Among the animals that had been fed with sputum no trace of tuberculosis was found, except here and there little nodules in the lymphatic glands of the neck, and in one case a few grey nodules in the lungs. The animals, on the other hand, which had eaten bacilli of bovine tuberculosis had, without exception (just as in the cattle experiment), severe tubercular diseases, especially tubercular infiltration of the greatly enlarged lymphatic glands of the neck and of the mesenteric glands, and also extensive tuberculosis of the lungs and the spleen.

The difference between human and bovine tuberculosis appeared not less strikingly in a similar experiment with asses, sheep and goats, into whose vascular system the two kinds of tubercle-bacilli were injected.

Our experiments, I must add, are not the only ones that have led to this result. If one studies the older literature of the subject, and collates the reports of the numerous experiments that were made in former times by Chauveau, Günther and Harms, Bollinger and others, who fed calves, swine, and goats with tubercular material, one finds that the animals that were fed with the milk and pieces of the lungs of tubercular cattle always fell ill of tuberculosis, whereas those that received human material with their food did not. Comparative investigations regarding human and bovine tuberculosis have been made very recently in North America by Smith, Dinwiddie and Frothingham, and their result agreed with that of ours. The unambiguous and absolutely conclusive result of our experiments is due to the fact that we chose methods of infection which exclude all sources of error, and carefully avoided everything connected with the stalling, feeding and tending of the animals that might have a disturbing effect on the experiments.

Considering all these facts, I feel justified in maintaining that human tuberculosis differs from bovine, and cannot be transmitted to cattle. It seems to me very desirable, however, that these experiments should be repeated elsewhere, in order that all doubt as to the correctness of my assertion may be removed.

I wish only to add that, owing to the great importance of this matter, the German Government has appointed a commission to make further inquiries on the subject.

But, now, how is it with the susceptibility of man to bovine tuberculosis? This question is far more important to us than that of the susceptibility of cattle to human tuberculosis, highly important as that is too. It is impossible to give this question a direct answer, because, of course, the experimental investigation of it with human beings is out of the question. Indirectly, however, we can try to approach it. It is well known that the milk and butter consumed in great cities very often contain large quantities of the bacilli of bovine tuberculosis in a living condition, as the numerous infection-experiments with such dairy products on animals have proved. Most of the inhabitants of such cities daily consume such living and perfectly virulent bacilli of bovine tuberculosis, and unintentionally carry out the experiment which we are not at liberty to make. If the bacilli of bovine tuberculosis were able to infect human beings, many cases of tuberculosis caused by the consumption of alimenta containing tubercle-bacilli could not but occur among the inhabitants of great cities, especially the children. And most medical men believe that this is actually the case.

In reality, however, it is not so. That a case of tuberculosis has been caused by alimenta can be assumed with certainty only when the intestine suffers first—*i.e.*, when a so-called primary tuberculosis of the intestine is found. But such cases are extremely rare. Among many cases of tuberculosis examined after death, I myself remember having seen primary tuberculosis of the intestine only twice. Among the great *post-mortem* material of the Charité Hospital in Berlin ten cases of priminary tuberculosis of the intestine occurred in five years. Among 933 cases of tuberculosis in children at the Emperor and Empress Frederick's Hospital for Children, Baginsky never found tuberculosis of the intestine without simultaneous disease of the lungs and the bronchial glands. Among 3104 *post mortems* of tubercular children, Biedert observed only sixteen cases of primary tuberculosis of the intestine. I could cite from the literature of the subject many more statistics of the same kind, all indubitably showing that primary tuberculosis of the intestine, especially among children, is a comparatively rare disease, and of these few cases that have been enumerated, it is by no means certain that they were due to infection by bovine tuberculosis. It is just as likely that they were caused by the widely propagated bacilli of human tuberculosis, which may have got into the digestive canal in some way or other—for instance, by swallowing saliva of the mouth. Hitherto nobody could decide with certainty in such a case whether the tuberculosis of the intestine was of human or of animal origin. Now we can diagnose them. All that is necessary is to cultivate in pure culture the tubercle-bacilli found in the tubercular material, and to ascertain whether they belong to bovine tuberculosis by inoculating cattle with them. For this purpose I recommend subcutaneous injection, which yields quite specially characteristic and convincing results. For half a year past I have occupied myself with such investigations; but, owing to the rareness of the disease in question, the number of the cases I have been able to investigate is but small. What has hitherto resulted from this investigation does not speak for the assumption that bovine tuberculosis occurs in man.

Though the important question whether man is susceptible to bovine tuberculosis at all is not yet absolutely decided, and will not admit of absolute decision to-day or to-morrow, one is nevertheless already at liberty to say that, if such a susceptibility really exists, the infection of human beings is but a very rare occurrence. I should estimate the extent of infection by the milk and flesh of tubercular cattle, and the butter made of their milk, as hardly greater than that of hereditary transmission, and I therefore do not deem it advisable to take any measures against it.

So the only main source of the infection of tuberculosis is the sputum of consumptive patients, and the measures for the combating of tuberculosis must aim at the prevention of the dangers arising from its diffusion. Well, what is to be done in this direction? Several ways are open. One's first thought might be to consign all persons suffering from tuberculosis of the lungs, whose sputum contains tubercle-bacilli, to suitable establishments. This, however, is not only absolutely impracticable, but also unnecessary. For a consumptive who coughs out tubercle-bacilli is not necessarily a source of infection on that account, so long as he takes care that his sputum is properly removed and rendered innocuous. This is certainly true of very many patients, especially in the first stages, and also of those who belong to the well-to-do classes, and are able to procure the necessary nursing. But how is it with people of very small means? Every medical man who has often entered the dwellings of the poor, and I can speak on this point from my own experience, knows how sad is the lot of consumptives and their families there. The whole family have to live in one or two small, ill-ventilated rooms. The patient is left without the nursing he needs, because the able-bodied members of the family must go to their work. How can the necessary cleanliness be secured under such circumstances? How is such a helpless patient to remove his sputum, so that it may do no harm? But let us go a step further and picture the condition of a poor consumptive patient's dwelling at night. The whole family sleep crowded together in one small room. However cautious he may be, the sufferer scatters the morbid matter secreted by his diseased lungs every time he coughs, and his relatives close beside him must inhale this poison. Thus whole families are infected. They die out, and awaken in the minds of those who do not know the infectiousness of tuberculosis the opinion that it is hereditary, whereas its transmission in the cases in question was due solely to the simplest process of infection, which do not strike people so much, because the consequences do not appear at once, but generally only after the lapse of years.

Often, in such circumstances, the infection is not restricted to a single family, but spreads in densely inhabited tenement-houses to the neighbours, and then, as the admirable investigations of Biggs have shown in the case of the densely peopled parts of New York, regular nests or foci of disease are formed. But, if one investigates these matters more thoroughly, one finds that it is not poverty *per se* that favours tuberculosis, but the bad domestic conditions under which the poor everywhere, but especially in great cities, have to live. For, as the German statistics show, tuberculosis is less frequent, even among the poor, when the population is not densely packed together, and may attain very great dimensions among a well-to-do population when the domestic conditions, especially as regards the bedrooms, are bad, as is the case, for instance, among the inhabitants of the North Sea coast. So it is the overcrowded dwellings of the poor that we have to regard as the real breeding-places of tuberculosis; it is out of them that the disease always crops up anew, and it is to the abolition of these conditions that we must first and foremost direct our attention if we wish to attack the evil at its root, and to wage war against it with effective weapons.

This being so, it is very gratifying to see how efforts are being made in almost all countries to improve the domestic conditions of the poor. I am also convinced that these efforts, which must be promoted in every way, will lead to a considerable diminution of tuberculosis. But a long time must elapse ere essential changes can be effected in this direction, and much may be done meanwhile in order to reach the goal much more rapidly.

If we are not able at present to get rid of the danger which small and overcrowded dwellings involve, all we can do is to remove the patients from them, and, in their own interests and that of the people about them, to lodge them better; and this can be done only in suitable hospitals. But the thought of attaining this end by compulsion of any kind is very far from me; what I want is that the consumptives may be enabled to obtain the nursing they need better than they can obtain it now. At present a consumptive in an advanced stage of the disease is regarded as incurable and as an unsuitable inmate for a hospital. The consequence is that he is reluctantly admitted and dismissed as soon as possible. The patient, too, when the treatment seems to him to produce no improvement, and the expenses, owing to the long duration of his illness, weigh heavily upon him, is himself animated by the wish to leave the hospital soon. That would be altogether altered if we had special hospitals for consumptives, and if the patients were taken care of there for nothing, or at least at a very moderate rate. To such hospitals they would willingly go; they could be better treated and cared for there than is now the case. I know very well that the execution of the project will have great difficulties to contend with, owing to the considerable outlay it entails. But very much would be gained if, at least in the existing hospitals, which have to admit a great number of consumptives at any rate, special wards were established for them, in which pecuniary facilities would be offered them. If only a considerable fraction of the whole number of consumptives were suitably lodged in this way, a diminution of infection and consequently of the sum total of tuberculosis could not fail to be the result. Permit me to remind you in this connection of what I said about leprosy. In the combating of that disease also great progress has already been made by lodging only a fair number of the patients in hospitals. The only country that possesses a considerable number of special hospitals for tubercular patients is England, and there can be no doubt that the diminution of tuberculosis in England, which is much greater than in any other country, is greatly due to this circumstance. I should point to the founding of special hospitals for consumptives and the better utilisation of the already existing hospitals for the lodging of consumptives as the most important measure in the combating of tuberculosis, and its execution opens a wide field of activity to the State, to municipalities, and to private benevolence. There are many people who possess great wealth, and would willingly give of their superfluity for the benefit of their poor and heavily afflicted fellow-creatures, but do not know how to do this in a judicious manner. Here is an opportunity for them to render a real and lasting service by founding consumption hospitals or purchasing the right to have a certain number of consumptive patients maintained in special wards of other hospitals free of expense.

As, however, unfortunately, the aid of the State, the municipalities, and rich benefactors will probably not be forthcoming for a long time yet, we must for the present resort to other measures that may pave the way for the main measure just referred to, and serve as a supplement and temporary substitute for it.

Among such measures I regard obligatory notification as specially valuable. In the combating of all infectious diseases it has proved indispensable as a means of obtaining certain knowledge as to their state, especially their dissemination, their increase and decrease. In the conflict with tuberculosis also we cannot dispense with obligatory notification; we need it not only in order to inform ourselves as to the dissemination of this disease, but mainly in order to learn where help and instruction can be given, and especially where the disinfection which is so urgently necessary when consumptives die or change their residences has to be effected. Fortunately it is not at all necessary to notify all cases of tuberculosis, nor even all cases of consumption, but only those that, owing to the domestic conditions, are sources of danger to the people about them. Such limited notification has already been introduced in various places, in Norway, for instance, by a special law, in Saxony by a ministerial decree, in New York and in several American towns, which have followed its example. In New York, where notification was optional at first and was afterwards made obligatory, it has proved eminently useful. It has thus been proved that the evils which it used to be feared the introduction of notification for tuberculosis would bring about need not occur, and it is devoutly to be wished that the examples I have named may very soon excite emulation everywhere.

There is another measure, closely connected with notification, viz. disinfection, which, as already mentioned, must be effected when consumptives die or change their residence, in order that those who next occupy the infected dwelling may be protected against infection. Moreover, not only the dwellings but also the infected beds and clothes of consumptives ought to be disinfected.

A further measure, already recognised on all hands as effective, is the instructing of all classes of the people as to the infectiousness of tuberculosis, and as to the best way of protecting oneself. The fact that tuberculosis has considerably diminished in almost all civilised states of late is attributable solely to the circumstance that knowledge of the contagious character of tuberculosis has been more and more widely disseminated, and that caution in intercourse with consumptives has increased more and more in consequence. If better knowledge of the nature of tuberculosis has alone sufficed to prevent a large number of cases, this must serve us as a significant admonition to make the greatest possible use of this means, and to do more and more to bring it about that everybody may know the dangers that threaten him in intercourse with consumptives. It is only to be desired that the instructions may be made shorter and more precise than they generally are, and that special emphasis be laid on the avoidance of the worst danger of infection, which is the use of bedrooms and small ill-ventilated workrooms simultaneously with consumptives. Of course the instructions must include directions as to what consumptives have to do when they cough and how they are to treat their sputum.

Another measure, which has come into the foreground of late, and which at this moment plays to a certain extent a paramount part in all efforts for the combating of tuberculosis, works in quite another direction. I mean the founding of sanatoria for consumptives.

That tuberculosis is curable in its early stages must be regarded as an undisputed fact. The idea of curing as many tubercular patients as possible in order to reduce the number of those that reach the infectious stage of consumption, and thus to reduce the number of fresh cases, was therefore a very natural one. The only question is whether the number of persons cured in this way will be great enough to exercise an appreciable influence on the retrogression of tuberculosis. I will try to answer this question in the light of the figures at my disposal.

According to the business report of the German Central Committee for the Establishment of Sanatoria for the Cure of Consumptives, about 5500 beds will be at the disposal of these institutions by the end of 1901, and then, if we assume that the average stay of each patient will be three months, it will be possible to treat at least 20,000 patients every year. From the reports hitherto issued as to the results that have been achieved in the establishments we learn further that about 20 per cent. of the patients that have tubercle-bacilli in their sputum lose them by the treatment there. This is the only sure test of success, especially as regards prophylaxis. If we make this the basis of our estimates, we find that 4000 consumptives will leave these establishments annually as cured. But, according to the statistics ascertained by the German Imperial Office of Health, there are 226,000 persons in Germany above fifteen years of age who are so far gone in consumption that hospital treatment is necessary for them. Compared with this great number of consumptives the success of the establishments in question seems so small that a material influence on the retrogression of tuberculosis in general is not yet to be expected of them. But pray do not imagine that I wish, by this calculation of mine, to oppose the movement for the establishment of such sanatoria in any way. I only wish to warn against the over-estimating of their importance which has recently been observable in various quarters, based apparently on the opinion that the war against tuberculosis can be waged by means of sanatoria alone, and that other measures are of subordinate value. In reality the contrary is the case. What is to be achieved by the general prophylaxis resulting from recognition of the danger of infection and the consequent greater caution in intercourse with consumptives is shown by a calculation of Cornet's regarding the decrease of mortality from tuberculosis in Prussia in the years 1889 to 1897. Before 1889 the average was 31·4 per 10,000, whereas in the period named it sank to 21·8, which means that, in that short space of time, the number of deaths from tuberculosis was 184,000 less than was to be expected from the average of the preceding years. In New York, under the influence of the general sanitary measures directed in a simply exemplary manner by Biggs, the mortality from tuberculosis has diminished by more than 35 per cent. since 1886. And it must be remembered that both in Prussia and New York the progress indicated by these figures is due to the first beginnings of these measures. Considerably greater success is to be expected of their further development. Biggs hopes to have got so far in five years that in the city of New York alone the annual number of deaths from tuberculosis will be 3000 less than formerly. I take this opportunity of most urgently recommending Dr. Biggs' organisation to the study and imitation of all municipal sanitary authorities.

Now, I do indeed believe that it will be possible to render the sanatoria considerably more efficient. If strict care be taken that only patients be admitted for whom the treatment of those establishments is well adapted, and if the duration of the treatment be prolonged, it will certainly be possible to cure fifty per cent., and perhaps still more. But even then, and even if the number of the sanatoria be greatly increased, the total effect will always remain but moderate. The sanatoria will never render the other measures I have mentioned superfluous. If their number become great, however, and if they perfoim their functions properly, they may materially aid the strictly sanitary measures in the conflict with tuberculosis.

If now, in conclusion, we glance back once more to what has been done hitherto for the combating of tuberculosis, and forward to what has still to be done, we are at liberty to declare with a certain satisfaction that very promising beginnings have already been made. Among these I reckon the consumption hospitals of England, the legal regulations regarding notification in Norway and Saxony, the organisation created by Biggs in New York, the sanatoria, and the instruction of the people. All that is necessary is to go on developing these beginnings, to test, and if possible to increase, their influence on the diminution of tuberculosis, and wherever nothing has yet been done, to do likewise.

If we are continually guided in this enterprise by the spirit of genuine preventive medical science, if we utilise the experience gained in conflict with other pestilences, and aim, with clear recognition of the purpose and resolute avoidance of wrong roads, at striking the evil at its root, then the battle against tuberculosis, which has been so energetically begun, cannot fail to have a victorious issue.

THE ROYAL HORTICULTURAL SOCIETY'S LILY CONFERENCE.

ON July 16 the Royal Horticultural Society held a conference on "lilies." Although by no means organised upon the same scale as the meeting was two years ago, when hybridisation was discussed, the one under consideration proved, nevertheless, of some importance and much interest.

An exhibition of lilies was also arranged for the same day and the following one, in the Society's Gardens at Chiswick, where the conference took place. The number of plants shown was not large, but taking into consideration the fact that many species had done flowering, while others were not yet in blossom, the series collected together may be put down as a fairly representative one. Possibly more examples might have been displayed if growers had had a little longer notice given to them.

As soon as the inevitable luncheon was cleared away from the tent, the chair was taken by Mr. H. J. Elwes, F.R.S., who had returned from abroad for the purpose. He was also put down upon the programme to give an address on lilies, discovered or brought into cultivation since the issue of his well-known monograph upon these plants.

The chairman, however, deputed this part of his task to Mr. J. G. Baker, F.R.S., and contented himself with making a series of interesting comments upon the various points alluded to by the different speakers. Mr. Baker's contribution being mostly descriptive, he merely alluded briefly in passing to the lilies discovered and in several cases taken up by horticulturists during the last twenty years.

The plants concerned came chiefly from Upper Burma and Central and Western China. Some of the new martagons, however, were discovered in California and North Carolina. Species from the first-mentioned locality were due to the efforts of Sir Henry Collett, while the Chinese ones were collected by French missionaries and by Dr. Henry, who was present and spoke at the conference.

Among the many species and varieties mentioned, one may allude to *Lilium mirabile*, found by one of the missionaries in Western China, and which is unique among lilies in possessing as it does a centrifugal inflorescence; in all others, the lowermost flowers upon the stalk are the first to open. *L. lowei* was shown to be the same thing as *L. bakerianum*, the latter name having priority.

Dr. Henry, who sent home no less than 13,700 specimens of plants, was the next to speak. He was not able to pay special attention to any one kind of plants, so had nothing very particular to say about the habitats of lilies.

He described a day's journey in Western China as up one side of a mountain and down again into the valley on the other side. This speaker also pointed out that there were thousands and thousands of these valleys, each with its own flora, and that there was ample room in the tracts of country he traversed for a hundred collectors of plants.

After several contributions had been made to the meeting, Mr. George Massee had something to say upon the fungoid diseases to which lilies are liable. The chairman had already pointed out how the scientific man was indebted to the professional horticulturist, who introduced and flowered many species that the former would otherwise be unable to figure from living species when monographing a genus, and, again, how the practical man gains through the work of the botanist. Mr. Massee showed very forcibly how the gardener does not profit as much as he might from the labours of the mycologist. Great intelligence was granted to the horticulturist, but within a certain circle; this did not, however, include an appreciation of many simple methods of prevention. For instance, Mr. Massee pointed out that by merely adding a little kainite or Strasburgh fertiliser the most serious "lily disease," which, when it has once taken a hold, is incurable, can be successfully warded off.

When the whole series of papers is printed, growers of lilies should find much information of use to them, while botanists should be grateful to have their knowledge of the species and varieties of lilies brought once more up to date.

WILFRED MARK WEBB.

THE PROPERTIES OF STEEL CASTINGS.

THE first of a series of papers on the result of researches carried out during several years at the Sheffield University College was read by Prof. J. O. Arnold before the Iron and Steel Institute on May 9.

This preliminary paper dealt only with castings composed mainly of iron and carbon. It was shown that such a composition was unsuitable to meet the demands of engineers. The maximum stress recorded in the series was 32·42 tons per sq. in., associated with an elongation of only 2 per cent., whilst the maximum ductility obtained was an elongation of 46 per cent. on two inches, correlated, however, with a maximum stress of only 19·2 tons per sq. in.

A long series of observations revealed the curious fact that no correlation exists between the densities and mechanical properties of steel castings.

The mechanical influence of annealing at 950° C. and slowly cooling from that temperature is, in the case of iron containing about 0·4 per cent. of carbon, exemplified by the following figures :—

Condition of steel	Elastic limit tons per sq. in.	Max. stress tons per sq. in.	Elongation per cent. on 2 in.	Reduction of area per cent.
As cast... ...	17·22 ...	23·41 ...	6·5 ...	8·4
After annealing..	10·08 ...	24·03 ...	24·5 ...	29·0

The micrographic effect of drastic annealing is shown in the drawing, CC 2, which has been reduced from a 6-inch circle magnified 315 diameters.

The constituents of the steel as cast present an irregular trellis-like pattern of pale ferrite or iron and dark pearlite or steel. In addition, small castings, or small parts of large castings, present curious brown-etching lines of a sulphur alloy,

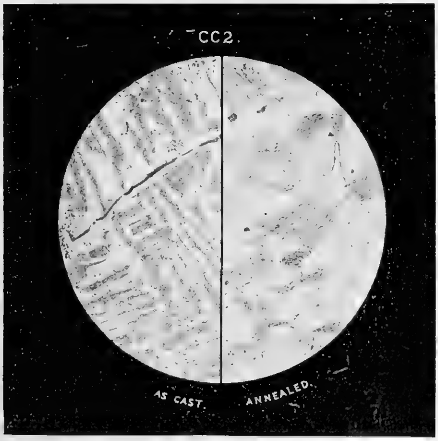


FIG. 1.—Casting CC2. (Reduced from six-inch circle, magnified 315 diameters.)

which arrange themselves almost exclusively along the ferrite, forming lines of dangerous weakness.

After annealing, the long lines of cleavage between the constituents are broken up, large patches of laminated pearlite and allotrimorphic crystals of iron being formed. At the same time, the dangerous lines of the attenuated sulphur alloy are destroyed, segregating into isolated patches. All the above features are well indicated in the micrograph figured. Steel castings often present mechanical discrepancies very difficult to explain, *e.g.* elongations per cent. and bending angles form measures of ductility which might be expected to be proportional to each other, but often such is not the case.

A remarkable feature of the results recorded is the fact that some of the castings built up of very large crystals have presented great ductility, whilst castings with that minutely crystalline structure usually supposed to give the best mechanical results have given unsatisfactory tests.

Considering the fact that such castings were of identical chemical composition and had been subjected to similar thermal treatment, it is difficult to avoid the conclusion that the initial temperature of the steel on casting may exert a permanent mechanical influence, and that consequently the operation of annealing is not thoroughly effective.

SCIENTIFIC WORK IN EGYPT.

SEVERAL matters of scientific interest are described in Lord Cromer's report upon the finances, administration and condition of Egypt and the Soudan. Particular attention is directed to Sir William Garstin's memorandum on irrigation, and to the value of the work of hydraulic engineers in Egypt. Sir William Garstin brings forward observations showing a continuous fall of level of Lake Victoria Nyanza. His remarks upon this fall and the rainfall observations available are here reprinted.

"*Lake Victoria Nyanza Rain Gauges.*—Information regarding the daily rainfall and the lake levels is now regularly received in Egypt from Uganda. The first series of registers, previous to the rebellion, dates from June 1, 1896, to July 31, 1897. The second series commences on September 1, 1898, and has been carried on to October 31, 1900. Unfortunately, it is impossible to connect the two series, as the gauges erected subsequent to the rebellion are not the same as those which formerly existed. We have, therefore, only twenty-six months of observations upon which to base possible theories. This is not sufficient, more especially as we are still ignorant of many important factors bearing upon the relations of the levels and rainfall of the equatorial lakes with the Nile supply. Information regarding the most important point of all, viz. the Albert Nyanza Lake, is still entirely wanting. This is much to be regretted, as this lake, which drains an enormous catchment area, and through the northern end of which passes the water coming from the Victoria Lake, is probably the most important of the reservoirs which feed the White Nile. It is to be hoped that early measures may be taken to erect gauges upon the Albert Lake and to observe them regularly. The records thus obtained would be invaluable to Egypt.

"The following facts, elicited from the rather meagre information at our disposal, may perhaps be of general interest :—

"Two observing stations now exist on the Victoria Lake, one on either side, viz. at Port Alice or Entebbe and at Port Victoria or Ugowe. Unfortunately, the rainfall register for Entebbe only commences from the month of April 1900, so a comparison between the two for the whole year is impossible.

"The Ugowe rain gauge record shows that 46·28 inches of rain fell in the twelve months ending with October 1900, that there were 131 rainy days, and that the storms invariably took place either in the afternoon or at night. Further, that February was the wettest month of the year and July the driest, 6·45 inches being registered for the former and 1·56 inches for the latter. It would also appear that the period of the heaviest rainfall is from November to May. The total rainfall for the six months in question was 30·73 inches, the remaining six months being responsible for only 15·55 inches.

"The rainfall at Entebbe, on the opposite side of the lake, was, so far as the records go, considerably heavier than at Ugowe. The total fall between April and November 1900 was 30·39 inches at the former place, as against 20·59 inches at the latter. As regards the rise and fall of the water surface of the lake it is possible to make a comparison, as registers have been supplied regularly from both stations. . . .

"The records, as far as they go, seem to prove that the lake is always at its lowest in October, *i.e.* at the end of the dry season, and at its highest in December or January. They also show that the lake level has been steadily falling for the last three years, thus :—

	Port Alice (Entebbe). Ft. in.	Port Victoria (Ugowe). Ft. in.
Lake levels on October 1, 1898 ...	3 2 ...	3 2½
,, ,, 1899 ...	2 6½ ...	2 2
,, ,, 1900 ...	1 7 ...	1 1

"It is possible that this fall in the levels may be, in some measure, due to degradation of the bed of the river in the channel whence it issues from the lake; but it seems to be far more probable that it has been caused by a failure of the rainfall over an immense area. All reports go to show, and all travellers who have visited these regions relate, that a severe drought has prevailed over a large portion of Central Africa during the last two years. This drought has extended as far north as the Egyptian Soudan.

"Although it may seem likely that the Nile flood of 1901 will be a poor one if these figures are correct, it would be misleading to attempt to draw any definite conclusions from them. The register of the rainfall only dates from a very recent period, and consequently no comparison can be made with the fall of previous years. Again, the available knowledge of the many factors, which together combine to produce the annual rise of the White Nile, is at present extremely scanty.

"Lastly, as has been already stated, the Albert Nyanza Lake must exercise a most important influence upon the volume of the river, but no attempt has as yet been made to collect information regarding it. It is most desirable that a regular register of its levels and its rainfall should be commenced and maintained as soon as possible."

The Sudd in the Bahr-el-Gebel.—Major Peake's sudd-cutting party removed, in all, fourteen blocks of sudd during 1900. Some of these blocks were, in places, a mile in length and from 15 to 20 feet in thickness. The surface of the river channel was completely closed, and the stream passed underneath the sudd with a high velocity. Sir William Garstin remarks that a visit to the work changed many preconceived ideas as the nature of the obstruction. Instead of the sudd being, as had been supposed, a tangle of weed floating on the water and descending a few feet below the surface, it proved, in most cases, to be a mass of decayed vegetation, papyrus roots and earth, much resembling peat in its consistency, and compressed into such solidity by the force of the current that men could walk over it everywhere, and even elephants could, in places, cross it without danger. The most effectual method of removing it was found to be by cutting deep trenches on the surface, thus dividing it into rectangular blocks of some 10 feet square. These were hauled out, block by block, by means of chains and wire hawsers attached to the gun-boats.

Two portions of the Bahr-el-Gebel still remain uncleared. The one commences at 140 miles south of Lake No, and is some 25 miles in length. The other is some 52 miles further south and about three miles long. In both instances the true channel of the river is blocked by sudd, and it now follows a false channel; in the former instance it passes through a series of broad, shallow lakes.

Survey of the Cataract Region.—Lord Cromer states that the construction of the Nile Reservoirs is now so far advanced that the time has arrived when further studies of the river may usefully be made, so that, should it eventually be found necessary to still further augment the water supply of Egypt, the requisite information for the preparation of the project, or projects, shall be at the disposal of the Ministry of Public Works. One of the first steps necessary to attain this end is to make an accurate survey of the Nile Valley where it passes through the cataract region south of Wady Halfa. It may eventually be decided that a second reservoir is not the best means of supplementing the summer volume of the river, but that it will be more advisable to obtain it by regulating the outlets of the Equatorial and Abyssinian Lakes, by opening up the Bahr-el-Gebel, or some other large scheme. Until, however, a thorough knowledge of the river, as a whole, has been obtained, it would be premature and unadvisable to take any decision whatsoever. The present work is a commencement in this direction, and even should the results obtained, as regards the construction of another dam, prove to be negative, the information thus acquired will be invaluable to those charged with the control of the river.

It is proposed, therefore, to survey the cataract region, at the same time running lines of levels up the river valley. A geological surveyor will accompany the party. It is calculated that three years' work will be required to complete it as far south as the head of the third cataract.

Meteorological Department.—The Observatory, situated in the Abbassieh quarter of Cairo, was greatly improved during the course of last year. The equipment of a first-class meteorological observatory is now working there regularly. The time-ball at Port Said is dropped daily at noon by a current, working automatically, which is sent from the Observatory. Those at Cairo and Alexandria were to commence working early this year. The time of the 30° meridian east of Greenwich has been made civil time for the whole of Egypt, replacing the various local times previously in use.

Eight stations between Alexandria and Omdurman now take regular meteorological observations and send telegraphic weather reports to Cairo daily at 8 a.m. These are printed and published. Arrangements have recently been made by which similar telegraphic reports are daily exchanged at 8 a.m. between Alexandria, Malta, Brindisi, Trieste and Athens. These telegrams are posted for general information at the ports of Alexandria and Port Said.

The observations of all meteorological stations are printed and published monthly. The complete results of the work at the Central Observatory will be published shortly. The observations registered in 1899, together with the mean values of the preceding thirty years, are already printed and ready for publication.

Besides Omdurman, where there is a complete set of instruments, the stations of Rosaires, Fashoda, Wad Medani and Kassala now record rainy days and approximate fall. They have not yet been furnished with proper rain gauges. It is hoped that before long observing meteorological stations may be instituted at different points on the Blue and White Niles.

Funds have been granted for transferring the Central Observatory to Helouan, fifteen miles south of Cairo. The new building will be commenced this year. A set of thermometers has been sent to the base camp at Meshra-er-Rek, in the Bahr-el-Ghazal Province, to be registered and observed there daily.

Geological Survey.—The staff of the Geological Survey has been employed in compiling the results of the previous three years' field work. Reports on the oases of Kharga, Dakhleh and Farafra are on the point of being published; five other reports are ready for printing. Good progress has been made with the preparation of the maps, some of which will shortly be ready for publication. A geological museum is in course of construction, and will probably be completed before the end of the year. The expenditure on this building up to the end of last year was about £E. 2700.

The Preservation of Game.—Captain Stanley Flower, director of the Gizeh Zoological Gardens, is frequently asked questions as to the regulations existing for the preservation of game in the Soudan. The following statement from the report supplies information upon these matters.

A system of licenses for non-native sportsmen has been introduced. The licences are of two kinds: one is issued at £E. 25 and known as licence "A," authorising the shooting of every kind of game except a small class which is absolutely protected, the other issued at £E. 5 and known as licence "B," from which the rarer kinds of game are excluded. In addition to the licence fee of £E. 25, the holder of a licence "A" is required to pay a fee for each animal included in Class 2 which he may kill. A higher charge is made for female animals, but no female animal of the kind included in Class 2 may be knowingly shot. In the case of elephants the royalty upon ivory is also payable.

The Wild Animals Preservation Ordinance, 1900, also provided that natives might be requested to take out licences, but this provision only applies in districts where it is specially brought into force by a notice issued by the Governor-General. The terms of the licences are arranged by the licensing officer. This part of the Act has been brought into force as regards Kassala, and licences have been granted to the Sheikhs of two or three tribes to kill or capture a limited number of the bigger kinds of game. They pay nothing for their licence, but are required to inform the Mudir if they kill or capture any elephant, giraffe, buffalo or certain other kinds of game and to pay a fee varying from £E. 1 to £E. 8; as there is usually a demand at Kassala for specimens of wild animals, it is thought that the natives will readily pay the fees.

Several specimens of wild animals have been exported during the year, and there is also a certain traffic in skins and trophies. There was reason to fear that, unless the trade was controlled, it would lead to unnecessary destruction of the rarer sorts of animals. The Wild Animals Preservation Ordinance, 1901, which has been recently promulgated, places the export of wild animals and birds under Government control.

Section 2 prohibits the export of wild animals and birds, or of their skins, feathers, horns and trophies in an unmanufactured condition other than elephants' tusks, rhinoceros horn and ostrich feathers, except under Government permit. The provision does not apply to animals or birds which are killed under a game licence.

The Governor-General is empowered to permit the export of animals and birds of which there is no reason to fear the destruction and to impose a tax upon the same. Arrangements have been made to establish a special department of the Government under the general superintendence of Captain Flower, the Director of the Gizeh Zoological Gardens, to deal with questions relating to the wild animals and birds of the Soudan. Licences to export live specimens will be issued by this Department at fees to be determined later, and the Department will undertake the supply of specimens to Zoological Gardens, Museums and others.

Zoological Gardens.—Specia attention has been paid to the fauna of the Nile Valley. There were in the Gardens in October last 670 animals, representing 169 species, as compared with 473 animals, of 132 species, at the corresponding date in 1898. The most important acquisitions have been a giraffe, presented by Lord Kitchener, and a white oryx, from Kordofan, presented by Sir Reginald Wingate.

The staff of the Gardens was mainly employed during the year in rebuilding and repairing cages. An elephant-house has been built, and plans are being prepared for a new lion-house.

Nile Fish Survey.—The collecting of fish was, during the early part of the year, extended as far as Abu Hamed, and at present Mr. Loat, the specialist selected by the authorities of the British Museum, is working on the White Nile. A considerable number of plates, which will eventually be published, have been printed, and material from which others may be drawn has been obtained. A severe loss was sustained last year in the death of Dr. John Anderson, F.R.S., whose knowledge and experience made his advice of the greatest value in carrying out a work which was taken in hand owing to his initiative.

Egyptology.—Under the very capable direction of M. Maspero, a great improvement has recently taken place in the working of all branches of the Archæological Department. Notably, the appointment of two English inspectors-in-chief has done much to preserve the monuments, both in Lower and Upper Egypt, from further depredation and mutilation.

Work has been proceeding at Karnak. It will be remembered that eleven columns in the Great Hall fell to the ground during the flood of 1899. Five further columns appeared to be in some danger of falling. Under the direction of MM. Legrain and Ehrlich, these columns have now been dismantled; others have been strengthened and repaired. The *débris* of the stones which had fallen has been removed, labelled and arranged in such a manner as to render it possible, should it ever be decided to rebuild these columns, to replace each separate stone in the precise position which it formerly occupied.

Lord Cromer says he has been informed, on high technical authority, that, in spite of every precaution, the remaining portions of this splendid monument of antiquity will of necessity be exposed to considerable risk every year at the period when the subsoil water is falling. A very heavy expenditure of money would, without doubt, minimise this risk, but it is doubtful whether, under any conditions, it will be possible to obviate it completely.

The bases of the columns are of insufficient strength; the soil is unstable; each column supports an immense weight in the shape of roofing-blocks; and the whole structure has been erected without mortar and without bond of any sort.

The principal tombs at Thebes have been closed by gates. The tomb of Amenophis II. has been so arranged that the Royal mummy remains *in situ*, and can be seen by visitors. M. Maspero is studying a project for lighting these tombs by electricity, so as to obviate the destruction to the wall paintings caused by the candles used by visitors.

Technical Education.—The only important technical school in Egypt is that situated in the Boulac quarter of Cairo. The School of Agriculture is a very popular institution, and is rendering good service to the country, but more institutions of this kind seem to be needed.

Lord Cromer refers particularly to the educational needs of Egypt, and suggests that attention should be given to technical education in all its branches. He has discussed this subject with various authorities in Egypt, and finds a general disposition to do something towards the improvement and extension of technical instruction. Mr. J. Currie, director of education in the Soudan and Principal of the Gordon College, has reported upon the subject, and extracts from his report are given by Lord Cromer. It is proposed to establish a large industrial school at Khartoum, to be worked in connection with the Government dockyards and workshops. It is also proposed to find house-room for, and supervise, the following institutions at Gordon College, so far as that can be possible: (*a*) A general Soudan reference library; (*b*) an economic museum, to assist in the commercial development of the country; (*c*) a meteorological station and a small observatory; (*d*) a small analytical laboratory.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MISS E. S. BARCLAY has bequeathed to Bedford College the sum of 1000*l.* without conditions.

WE learn from *Science* that Pittsburg will probably soon have a great technical institution, especially adapted to its needs and as complete in the industrial field of education as the Carnegie Institute of that city has become in art and æsthetics. An advisory committee appointed to determine the best plan and most suitable scope of the new institution has just presented its report to Mr. Carnegie. These expert advisers were Dr. R. H. Thurston, Director of Sibley College, Cornell University, Prof. J. B. Johnson, Dean of the College of Engineering, University of Wisconsin, Prof. Thomas Gray, of the Rose Polytechnic School, and Prof. V. C. Alderson, of the Armour Institute. The scheme proposed includes three different and distinct forms of school which may be combined as parts of one complete technical university. If the whole scheme is accepted by Mr. Carnegie, there will be, in the first place, a first-class technical college. "This college," says the committee, "should be made attractive to the greatest scholars in the fields of physical and chemical science. To obtain and hold such men they must be given ample opportunities for research. This college must be supplied, therefore, not only with great experimental shops and laboratories for students' use, but in all departments there should be splendidly equipped laboratories of investigation and research, under the direction of the head of such department, and with a full corps of assistants for the carrying on of all lines of investigation which are now partly or wholly unprovided for in America." There will also be a Technical High School to carry on work above that of the public grammar school, and day and evening classes for the benefit of those who are unable to take advantage of the more complete courses in this school. Mr. Carnegie has now to decide whether he will found a school for artisans, a technical high school or a technical college, or, if his ambition mounts so high, a true technical university including them all.

AN article by Mr. J. B. C. Kershaw in the July number of the *Monthly Review* contains a few facts which should be of interest to all who are concerned with educational and national progress. He points out that technical education as at present carried on in this country is chiefly instrumental in giving to great numbers of young people elementary instruction in every subject except the dead languages. In the opinion of practical men, this smattering of science and other subjects is of no value from an industrial point of view, and as a system for bringing the few who possess undoubted ability or genius to the front it is costly and unnecessary. In England the aim has been to educate the rank and file of the workers, but the German aim is to educate thoroughly all who are to occupy posts of authority in manufactures and industries. Herein there is a great difference, and many people are beginning to see that the German method is the best when industrial progress is taken as the criterion. The reason lies in the ability to appreciate new developments, or, as Mr. Kershaw puts it, "a thorough scientific training enables the manufacturer to decide quickly upon the merits of the new processes or inventions, and he is not daunted by the fact that in this newly-chosen path of industrial progress there is no 'practical experience' to guide his steps. The German manufacturer has, therefore, been assisted by his own thorough technical training, and by that of his manager, engineer or chemist, in adapting himself more quickly than his English rival to new conditions of trade, or to the exigencies of new processes and new developments of industry." There is little hope of substantial improvement while our manufacturers and commercial men, as a rule, have so little sympathy with scientific work. Their general attitude is reflected in advertisements of this kind—"Wanted, young man as Chemist at Tar and Vitriol Works in North of England; willing to fill up time at Bookkeeping." While trained chemists are considered to be on about the same level as a clerk and inferior to a skilled operative, how can we expect to make advances similar to those which Germany and the United States are making?

SOCIETIES AND ACADEMIES.

LONDON.

Royal Microscopical Society, June 19.—Mr. William Carruthers, F.R.S., president, in the chair.—Mr. T. H. Powell exhibited *Coscinodiscus asteromphalus* under a new 1/40th-inch apochromatic oil immersion objective.—Mr. J. W. Gordon read a paper entitled "An examination of the Abbe diffraction theory of the microscope," in which he stated that the above long-accepted explanation of the phenomena of high-power microscopic observation had been accepted on insufficient proof and would not bear the test of critical examination. The Abbe theory claimed that pictures formed by the microscope of very minute objects were due to diffraction images originated by the object, and that when the oblique rays of light in which these diffraction images existed were excluded, no image of the object was possible. This theory had been experimentally illustrated by Prof. Abbe by means of a grating on the stage of the microscope and a series of diaphragms behind the microscope object glass with slits to partially exclude oblique rays. Mr. Gordon showed that although in favourable circumstances diffraction effects were produced by fine objects on the stage of the microscope, these effects did not appreciably influence the formation of the image. He also showed that the experimental results produced by the above-mentioned diaphragms, which were adduced to prove the theory, were due to a diffraction effect produced by the diaphragms themselves and not by the grating on the stage of the microscope, the same results being obtained with an aërial image of a grating projected upon the stage by a lens in place of the actual grating. He maintained that in the microscope, as in the telescope, it was necessary to eliminate diffraction effects as far as possible by making lenses of large aperture, and not, as in Abbe's theory, to include as many diffraction phenomena as possible. Diagrams in illustration of the paper were thrown upon the screen, and the various experiments referred to were exhibited under a number of microscopes. In the discussion that followed, Prof. S. P. Thompson agreed with Mr. Gordon in rejecting the presentation of the Abbe theory given by Naegeli and Schwendener, but found himself at variance with Mr. Gordon on almost every other point, and proceeded to discuss several conclusions arrived at in the paper.

PARIS.

Academy of Sciences, July 15.—M. Fouqué in the chair.—Determination of three principal optical parameters of a crystal, in magnitude and direction, by the refractometer, by M. A. Cornu. Though the measurement of the three principal indices of a crystal is relatively easy, the determination of the three principal directions involves calculations too intricate for ordinary work. A geometrical study of the total reflection at a crystalline surface has led the author to some analytical relations upon this application of the refractometer, of unexpected simplicity. Numerous observations of crystals with an Abbe refractometer have shown that the formulæ developed are exact within the limits of error of the experimental results. Large clinorhombic crystals of commercial tartaric acid have been used in the experiments to test the formulæ. The demonstration of the formulæ and the numerical results are reserved for a future communication.—On the morphology and position of flagellated parasites with undulating membrane, by MM. A. Laveran and F. Mesnil. The characteristics of organisms of the two genera Trypanosoma and Trichomonas are described and compared, and the distinctive features are defined. The former genus comprises all the flagellated parasites which have been found in the blood of vertebrates.—Can poisoning be caused, through the skin and mucous membrane, in a medium which has been rendered irrespirable by sulphuretted hydrogen? by M. A. Chauveau. Experiments with dogs have shown that, provided an inhaling apparatus is worn upon the head, no ill effects ensue, even if the body of the animal is in an atmosphere charged with sulphuretted hydrogen so as to be poisonous.—On the sugars from blood, by MM. R. Lépine and Boulud. In the blood of dogs fed upon meat, or fasting, a sugar has been found analogous to saccharose, but differing from it in some properties.—On a new joint with variable angle, by M. G. Koenigs.—On the extension of the Riemann method of integration, by M. J. Coulon.—On the solution of equations of elasticity, in the case where the values of the unknowns at the limit are known, by MM. Eugène and F. Cosserat.—On the movement of a pendulum in a resisting medium, by M. L. Décombe.—On the changes of phase produced in incident rays in the neighbourhood of total reflection, but lower than the limiting angle, by M. J. Macé de Lépinay.—Measures of wave-length in the solar spectrum; comparison with Rowland's scale, by M. Perot and C. Farry. Thirty-three lines in the solar spectrum have been compared directly with the green light of cadmium, and the wave-lengths have been plotted. The observations suggest that Rowland's scale of wave-lengths is not perfect, and indicate where corrections might be made.—On the direction of magnetisation in beds of clay transformed into hard brick by layers of lava, by MM. B. Brunhes and P. David. It is known that clay baked in a furnace acquires magnetisation in the direction of the terrestrial magnetic field at the time when it is transformed into the condition of brick. The authors have examined some beds of hardened clay covered with lava near Clermont, in the Auvergne district, with the idea of finding the magnetic condition. It appears that in general the magnetic condition of the beds is decidedly different from that of the neighbourhood, and the difference is taken to indicate the change which has occurred since the epoch when the clay was baked by the lava flow.—Thermal study of potassium hydrates, by M. de Forcrand. The observations indicate that in addition to the two compounds KOH and $KOH + 2H_2O$ there are two other intermediate hydrates, viz. $KOH + 0{\cdot}5H_2O$ and $KOH + H_2O$.—On some derived phenyl ether compounds, by M. P. Brenans. The author describes some ether-oxides and ether salts of diiodophenol and triiodophenol.—Action of pyridine bases on tetra-chloro-benzo-quinones, by M. Henri Imbert.—New reactions with *c*-butyrylacetylacetate of methyl, by M. A. Haller.—On pyromucic and isopyromucic acids, by M. Chavanne.—Contribution to the study of ortho-xylene bichloride, by M. L. Ferrand.—Precautions to be taken in the study of parthenogenesis in sea-urchins, by M. C. Viguier.—Germination of the spores of Pencillium in humid air, by M. P. Lesage.—Formation of layers of ice, in summer, in the volcanoes of Auvergne, by M. P. Glangeaud.—Action of currents of high frequency and tension on urinary secretion, by MM. Denoyés, Martes and Rouvière.—Observations of a meteor at Floirac (Gironde) on July 5, by M. E. Esclangon.—On the action of the electric current on microbes, by MM. Apostoli and Laquerrière.

CONTENTS.

THURSDAY, AUGUST 1, 1901.

SPECULATIVE BIOLOGY.

Les Problèmes de la Vie. Essai d'une interprétation scientifique de phénomènes vitaux. I[e] Partie. *La Substance Vivante et la cytodiérèse.* By Dr. Ermanno Giglio-Tos, of the University of Turin. Pp. viii + 286. Thirty-three figures. (Turin: Chez l'auteur, Palais Carignano, 1900.) Price, 10 francs.

At a time when many, if not most, biologists are confessing that they find no helpful analogy between the operations of not-living matter and the adaptive and coordinating activities of the living organism, it is interesting to find one who maintains that vital phenomena are much simpler than they seem. It is maintained in the book before us that we have invested with a veil of mystery what are really "the natural consequences of chemical, physical and mechanical phenomena." This has been a frequently recurrent idea in the history of biology; but the author has worked it out in a theoretical system in which biomolecules and biomores, bioplasm and biomonads play a part supposed to be comparable to that of atoms and molecules and radicals in chemistry.

The fundamental facts of life with which Dr. Giglio-Tos begins his materialistic reconstruction of biology are assimilation and reproduction. In assimilation, the organism adds to its own organisation at the expense of material different from itself; in reproduction, it gives rise to other units which are actually or potentially like itself. These processes of growth and multiplication may seem simple in words, but whenever we pass to the things themselves they impress us as marvellous, even in simple creatures like amœba or diatom, monad or microbe, coccidian or myxomycete. And the impression of marvellous complexity, in spite of apparent simplicity, is heightened whenever the organisms show, as they so often do, some evidence of "behaviour" (whether it be chemotactic attraction and repulsion or adaptive and coordinated movements in search of food). But by dwelling on this "behaviour," which seemed to us of the very essence of life, we have become blind—so this book suggests—to the real simplicity of the assimilative and reproductive processes, which are "truly and exclusively chemical." To prove this last statement directly is not at present possible, for we do not know the chemical composition of living matter; but what the author proposes is the legitimate and practicable test—Are the interpretative formulæ of the chemist sufficient for a simpler re-description of vital phenomena? His answer is an emphatic affirmative. To be convinced, we are invited to make a simple experiment, in regard to which a chemist's opinion would be of much interest. We are told to "feed" two molecules of acetic acid with perchloride of phosphorus; and the resulting chloride of acetyl with zinc-ethyl; we are asked to subject the resulting methyl-ethyl-ketone to oxidation; and the result is that from two molecules of acetic acid we get four.

"May we not say that the two molecules of acetic acid have assimilated and reproduced? . . . Reproduction is the fission of a living molecule ('biomolecule'), which, after a series of assimilatory reactions, divides into other molecules of the original constitution."

We do not ourselves find any cogent evidence to show that a living molecule or biomolecule exists, or that it is needed as a theoretical postulate in biological interpretation; it seems to us highly probable that living matter is a complex mixture (organisation or synthesis) of organic substances whose virtue is in their interrelations; we do not see in the acetic acid story more than an analogy of very doubtful suggestiveness. But we must let the author tell his own tale. He devotes his second chapter to mapping out the possible developmental cycles of the imaginary biomolecule. Through phases of assimilation, followed by rearrangement of atoms, the biomolecule matures and multiplies, and there are three possible schemes: of (I.) autogenetic, (II.) homogenetic and (III.) heterogenetic development:—

(I.) a becomes b, then c . . . . d . . . . m, which divides into $a+a$.

(II.) a' . . . . b' . . . . c' . . . . d' . . . . $m'=e'+e'$ (and e' may thereafter give rise to $a'+a'$).

(III.) a'' . . . . b'' . . . c'' . . . . d'' . . . . $m''=e''+i''$ (of which e'', called genetic, may regenerate a'', while i'', called somatic, cannot).

The third chapter, dealing with the physiology of the biomolecule, discusses at some length the proposition that "respiration is not a process of combustion but of oxidation," and that the formation of CO_2 is an indirect result, comparable to what occurs when acetic acid acts on isocyanate of ethyl. The author is under a misapprehension when he says that "respiration is generally regarded to-day as a simple combustion . . . . an interpretation accepted by almost all biologists." Although we cannot explain *how* the oxygen, as Pflüger said, helps to wind up the vital clock, although we cannot as yet trace the oxygen through its sojourn in the tissues, we have left the false simplicity of the crude combustion theory far behind. In the pages of the book devoted to this subject, and in those dealing with the formation of starch in vegetable cells, the author argues against positions long since abandoned, and makes no new contribution to the problems.

The fourth chapter introduces us to "the biomore," an old acquaintance with a fresh alias, the visible living particle. It is, of course, formed of biomolecules, probably different from one another and juxtaposed like the inorganic molecules in double salts. The life of the biomore is not dependent on its constitution; it lives because it is formed of molecules themselves alive. Nevertheless, the accomplishment of vital functions is facilitated by the juxtaposition of the biomolecules, and by the increase in their instability which thus results. The arrangement of the biomolecules in the biomore depending on their chemical constitution, there is in the biomore, during assimilation, a continual displacement of biomolecules by reason of their chemical changes. Physiologically considered, "the biomore is a veritable mutual symbiosis of biomolecules." Had the author developed the fruitful idea of "symbiosis," he might have been led to the conception of "protoplasm" (=bioplasm) as an organisation of substances not in themselves living, but in virtue of their interrelations giving rise to the phenomena of life.

The next chapter deals with bioplasm and the biomonad—to wit, protoplasm and the cell—another instance of the craze for rechristening. Perhaps a micrococcus or some similar microbe is composed of but one biomore, but such simplicity is rare. Most unicellular organisms consist of diverse biomores living symbiotically in an interbiomoric fluid (water, nutritive substances in solution and products of secretion). The author explains that *bioplasm* includes nucleoplasm as well as cytoplasm, and that it excludes the metaplasm; it is Huxley's protoplasm, in fact. The *biomonad* is a living unity, a symbiotic system of biomores, characterised by the chemical nature of the biomores which form the nucleus; it is a cell, in fact. But while the author emphasises the fact of symbiosis, he does not, as we have said, really appreciate the idea that vitality is an expression of the interrelations of diverse complex substances associated in a particular organisation or synthesis.

"The faculty of living resides in the biomolecules themselves. The biomores are living because they are composed of biomolecules. The bioplasm is living because it is composed of biomores. The cell is living because it consists of bioplasm. . . . The phenomena of life and their possibility are based on the properties of carbon compounds. . . . The essential characteristic of life, reproduction, is fundamentally a phenomenon of molecular fission into two or more equal molecules."

Thus assertion follows assertion, all, to our thinking, "in the air."

The author's interpretation of cell-division, which is the subject of the three final chapters of this volume, may be inferred from what has been already noticed in regard to the process by which four molecules of acetic acid may be produced from two. Assimilation is the indispensable, though not always sufficient, cause of the division; it leads to an orientation of atoms which makes a division of the biomolecule imperative; the division of the biomolecules provokes the division of the biomore, and the division of the biomores provokes the division of the biomonad. How this speculation in any way interprets the actual processes of cell-division we entirely fail to see; but we are not surprised to find the author insisting that the phenomenon of division is independent of the nature of the division-figures. The figures cannot be chemically interpreted, so they do not count for much. They are dependent on the initial disposition of the biomores in the biomonad.

Assimilation leads to doubling of biomolecules, and this to doubling of biomores; the doubling expresses itself as cell-division, because of the particular orientation of the component biomores, which in turn is due to their reciprocal attractions. If this be granted, it is possible to deduce a number of "rational laws of cell-division," which may be verified by observation. The author deduces no fewer than twenty-eight laws, but many of them read more like assertions, while others are certainly not deductions, but statements of observed fact. We must content ourselves with referring to the first three. The first law is that the living parts of the cell have all the same importance in cell-division; the biomores enjoy perfect equality; this is "a natural consequence of the previous interpretation," and, like it, is all in the air.

The second law is "that the divisions of the diverse parts of the cell are independent of one another," and the third "that the direction of the division of the nucleus is determined by the direction of the division of the cytoplasm." This may seem to the matter-of-fact a contradiction, but the author maintains "that between the cellular body and the nucleus there is at once a complete independence and a close dependence." This is too subtle for our understanding.

Recognising that the phenomena of cell-division, which he has interpreted as "purely and exclusively mechanical," were somewhat "ideal" ("sont naturellement quelque peu idéaux"), the author proceeds to discuss the modifications which the ideal scheme suffers in real life. Perhaps this may prove to be the most useful part of the book, for the author proposes a series of thirteen problems dealing with the influence of the position of the central corpuscles, of gravity, of mechanical obstacles, of pressure, of the cell-membrane, of adjacent cells, and so on (pp. 184–285). We do not propose to discuss these problems, for an appreciation of the author's mode of treatment is quite impossible to those who find themselves compelled to reject his premises. But let us state his general conclusions.

The property of dividing, which characterises living matter, is not due to a special force. It is a consequence of the constitution of living matter and of assimilation, which doubles the number of the parts of the system and may thus lead to the formation of two systems. The force which unites the parts of living substance in a system is the same as that which unites the parts of dead matter. This force is sufficient to explain the phenomena of division. The figures which characterise cell-division are the structural results of the constitution of living matter, and have no importance in the phenomenon, which is purely and exclusively mechanical. As to the direction of the division, it is partly determined by the position of the central corpuscles, but almost wholly by environmental influences in the widest sense.

Let us sum up our impression of this ambitious book. The author abstracts from his consideration of the living organism its most characteristic features of adaptive and coordinated behaviour, and thus gives a false simplicity to the whole problem. He invents a theoretical system of biomolecules, biomores, bioplasm and biomonads, which depends on the postulate that there are biomolecules—a gratuitous assumption, since it is quite as likely that matter exhibiting vital phenomena owes its virtue to the interrelations of a peculiar organisation or synthesis of not-living molecules. From the doubling of a chemical molecule (of acetic acid) he passes, with an entirely inadequate discussion of the magnitude of the step, to the structural division of a cell. In spite of his hypothetical diagrams, his mathematical formulæ and his twenty-eight so-called laws of cell-division, he leaves the problem all unsolved. The use of a hypothetical system is to furnish convenient modes of re-statement in simpler terms, but we cannot find that the system of Dr. Giglio-Tos makes the division of the amœba under our microscope any more interpretable than it was before. The author is continually combating the assumption of "special forces"—and here we are at one with him—but the neo-vitalists do not believe in vital force. They content themselves with disbelieving that the behaviour of a living organism is as yet interpretable in terms of the formulæ used by the chemist and the physicist. And we find nothing in this volume to shake this disbelief.

J. A. T.

A PHILOSOPHER ON EVOLUTION.

The Limits of Evolution. By Prof. Howison. Pp. xxvii + 380. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1901.) Price 7*s.* 6*d.* net.

THE main argument of the book is clearly summarised in the preface. Nothing has any real existence except mind. There are a number of coexistent minds. All else is but the items of their experience, which they arrange in order for themselves. God is the "fulfilled type of every mind," an ideal to which it is trying to assimilate itself. These minds are citizens of an eternal republic. They have had no origin in time. They have not been created in the sense in which the word is ordinarily understood. They are free: "nothing but their own light and conviction determines their action towards each other and towards God." This freedom is made possible by the substitution of a final for an efficient cause. "Real creation means such an eternal dependence of other souls upon God that the non-existence of God would involve the non-existence of all souls." Evolution is the "movement of things changeable towards the goal of a common ideal," and spirits can "neither be the product of evolution nor in any way subject to evolution," which can only reign in "the incomplete and tentative world of experience."

The first and last essays elaborate the theory, insisting always on the freedom of the will. It is in order to prove that the will is free that our author has established his republic of independent minds. If the mind of an individual man is merely part of the force that permeates the whole universe, it can have no freedom. Pantheism, therefore, must be rejected. Creation, too, in the old sense must be given up; if created, the mind can have no independence. Hence the assumption that it has had no beginning and will have no end. Thus war is declared against the monistic philosophy, according to which body and mind are but different aspects of what is divisible only in thought, and the mind, therefore, as perishable as the body.

Prof. Howison fears that philosophy is tending towards determinism, and this tendency he considers fraught with the gravest danger. No doubt if a man puts his determinism into practice, and, when called upon to act, feels that he is a mere automaton set in motion by influences from without, he is not one who can fill any post where energy and determination are required. We must imagine that our wills are free or we are helpless. Whether we are really free is unimportant. The belief is strong in almost every man, at any rate in almost every European. Most men are content to leave the matter undiscussed, holding that they have a real freedom, however inexplicable and even unthinkable it may be. But Prof. Howison tries to find a philosophic explanation for the belief, and, interesting as his book is, we cannot think that he has been successful.

Let us first consider his "republic of minds." They exist in a world the existence of which is "incomplete and tentative." Nothing but mind is really existent. We start, then, each of us with our own mind. And how do we become cognisant of the existence of other minds? This can only be through our bodily senses. Yet our bodies are not things really existent. Moreover, we cannot touch, see or hear other men's minds; we only infer their existence from their looking out upon us through their bodily eyes or speaking to us with their bodily vocal organs. Thus the existence of a real world of minds is accepted on the evidence that is obtained for us by mere phenomena. Next as to the free will that Prof. Howison has to offer us. If he reduced the whole universe to unreality except each man's own *ego*, then the mind would move *in vacuo*, not tyrannised over by any external influences. As he himself puts it, the condition of freedom for man is that "the world shall be a world of *phenomena*—states of his own conscious being, organised by his spontaneous conscious life—and not a world of 'things-in-themselves.'" But he does not make other minds mere phenomena.

Any individual mind must, therefore, be influenced from without by the other citizens of the republic of minds. No doubt even under these conditions there may be autonomy: the mind may decide *in accordance with its own character* which influence from without it will allow to prevail with it. The existence of other minds need not destroy autonomy in this sense. But free will, such as this, is quite consistent with the monism which Prof. Howison condemns. It is not the freedom in which the ordinary healthy man has at least a practical belief. He has the feeling that he can transcend his own nature, conquer his weaknesses and bad tendencies and develop other and better tendencies. It may be impossible to explain how he can have such a power. Certainly this book leaves us dependent on our instinctive feeling of freedom.

Next as to our author's view of evolution. Evolution, he insists, cannot explain the origin of life or the origin of mind. But no clear-headed evolutionist holds that evolution can originate. We must assume an underlying force which, through evolution, is variously manipulated and concentrated. As to the ultimate origin of the underlying force, evolution has nothing to say. This much we may concede. But Prof. Howison assumes that, not only mind, but *the individual mind* has existed from eternity, and in this he is unreasonable. The development of certain bodily organs proceeds *pari passu* with the development of mental power. We can trace the gradual evolution of nerve till it culminates in the human brain. We are bound to assume, then, that a particular mind is the product of evolution; like the body, it has been elaborated out of something that preceded evolution. This question is not fairly faced by Prof. Howison. In a footnote (p. 10) he allows that we can trace the upward steps of intellectual development, and there he leaves the matter, assuming as the basis of his dualistic philosophy that the mind of each individual has existed from eternity and has, apparently, been inserted extranaturally in the body.

Some of the contradictions involved in his system our author sees and attempts to remove. If each individual mind has an independent existence from eternity, monotheism seems to disappear. On the other hand, if monotheism is insisted on, what becomes of the free-willing, independent minds, the citizens of the republic of minds? We are expected somehow to accept what look like contradictory propositions simultaneously. Again, all minds are different from one another and yet all are straining towards the same ideal. Here is a sentence that aims at explaining this:—

"In fine, its self-definition (*i.e.* the self-definition of each spirit) is at the same stroke in terms of its own peculiarity, its own inerasable and unrepeatable *particularity*, and of the supplemental individualities of a whole world of others—like it in this possession of indestructible difference, but also like it in self-supplementation by all the rest: and thus it intrinsically has *universality*" (p. 353).

We have left little space for the discussion of the essays that deal less directly with the main argument. One of them gives an interesting account of later German philosophy, another deals with the "art-principle in poetry." The essay on the "Right relation of reason to religion" is certainly the best. Everywhere in the book, but most of all in the last-mentioned essay, we feel that the author is a man who hates any notion that is in itself or in its implications degrading to human nature. In religion he boldly rejects authority and bases it on reason, defined as the mind's own insight, as its true source.

There is much in the book that it is good to read. The author hates pessimism; most of all he hates determinism as a belief that unnerves the character and robs human life of what is best in it. But he has found no philosophic basis for his views. In fact, we have in this book an instance of what is not uncommon: a man's opinion is often of far greater value than all the reasons he is able to give for it.

COAL MINING.

A Text-Book of Coal-Mining. By Herbert W. Hughes. 4th edition. Pp. 513: 670 figures. (London: Griffin and Co., Ltd., 1901.) Price 24*s.* net.

MR. HUGHES and his publishers may fairly be congratulated on the success of a text-book which requires a new edition about once in every three years, and this, too, in spite of its high price, which is beyond the means of the average student. The new edition contains ninety more pages and 184 more illustrations than the first.

It can hardly be expected that a large treatise of this description should be free from some minor errors; but when these are decidedly numerous, one cannot help feeling that there is want of care on the part of the author. Mr. Hughes seems to think (p. 3) that reversed faults are rare; surely he can never have carefully looked at the sections of some of the Continental coalfields. On p. 4, while speaking of the Carboniferous system in Scotland, he appears to be ignorant of the coal in the Calciferous Sandstone below the Carboniferous Limestone.

The chapter on boring is weak; it may be said with a good show of truth that the colliery engineer nowadays frequently entrusts the work of boring to a contractor; but this is an argument for omitting the chapter altogether, rather than for treating the subject in a slovenly fashion. There is no figure of a derrick of any kind. On p. 22 it is stated that the American boring tool is rotated by hand; this was done formerly, nowadays turning by hand has been given up. The rotatory and percussive systems of boring are mixed up in a manner puzzling to the student, for the description of the diamond drill says: "This method differs from the others in the fact that the tool receives a rotary instead of a percussive motion"; and yet just above, on the very same page, Mr. Hughes has been describing Davis's calyx drill, which works by rotation.

Timbering is not treated so fully as one would like, and we scarcely think that Haselmann would be content to hear his process of preserving timber spoken of as similar to the Aitken process.

An author should be consistent. In speaking of the transmission of power (p. 46), it is said that the choice is limited to compressed air and electricity, and yet a little further on we have a description of Brandt's drill, which is driven by water.

Mr. Hughes is wrong in supposing that the "straw" cannot be employed for igniting charges of explosives other than gunpowder. He is a little behind the times with regard to water injection while boring, as he makes no mention of Bornet's system, which is an unquestionable improvement upon the method tried at Blanzy in 1889, and not 1899.

Granted that some knowledge of electricity on the part of the mining engineer is nowadays desirable, if not imperative, is it not better that he should obtain the rudiments of that knowledge first-hand from an electrician rather than second-hand from a miner? Why should the writer of a mining text-book think it his business to explain the electrical units? Mr. Hughes evidently expects the student to learn elsewhere what is meant by such terms as "limestone," "sandstone," "horse-power," "symbol," "molecular weight"; why then does he go out of his way in the case of electricity, upon which subject there is ample published information? As a consequence, we find the mistake of defining the ampere as "the quantity per minute."

In the same way, it would be better to leave the question of generation of power to an expert. Steam-boilers are mentioned in a somewhat cursory fashion, and all other modes of generating power ignored. One of the statutory fittings to the boiler, viz. the safety valve, is described, but the other two, the water gauge and the steam pressure gauge, are not noticed.

On page 432, Mr. Hughes revives the old question whether the introduction of safety lamps will not produce an increase in the number of deaths from falls of roof and side. Statistics have shown that this fear is ungrounded, and it is a pity to throw doubts upon the subject.

While calling attention to the existence of very numerous minor defects, one cannot be blind to the useful work which Mr. Hughes has done in compiling what is unquestionably the best text-book on coal-mining in the English language, and for keeping it up to date. For this he well deserves the thanks of students and mining engineers. Plate II., reproduced from Mr. Hughes' own photographs, is excellent.

OUR BOOK SHELF.

The Human Nature Club. By E. L. Thorndike. Pp. viii + 235. (London: Longmans, 1901.)

Psychology of Reasoning. By Alfred Binet. Pp. 188. No. 47 of the "Religion of Science Library." (London: Kegan Paul, 1901.)

MR. THORNDIKE, already favourably known by his ingenious experimental studies of animal intelligence, has achieved a very fair measure of success in the bold attempt to compose an easy introduction to psychology in dialogue form. His little work is bright and interesting, and should be found an excellent introduction to the genetic study of mental processes. In particular, it is well adapted to be taken up as a first course preliminary to the study of Prof. James' great "Principles of Psychology." In some respects Mr. Thorndike, perhaps, defers too much to the authority of his eminent countryman. When his book reaches a second edition he might do well to add to the chapter in which Prof. James' well-known theory of the emotions is expounded some indication of the grave difficulties which beset the theory, and the flaws of the reasoning by which it is supported. Perhaps, too, he will see reason to modify the passage in which he repeats certain weak metaphysical arguments of the professor in favour of the immortality of the soul. Mr. Thorndike's one really weak point is his style. Dialogue, to be successful, should never be a direct imitation of actual speech, still less of a type of speech like that of Mr. Thorndike's characters, which is at once undignified, ungraceful, and occasionally gravely inaccurate, as, *e.g.*, when the brain is spoken of as "just a 'lot' of nerve-cells," an expression as unfortunate as it is inelegant.

The translation of M. Binet's interesting little work, which appears identical with one issued by the same publishers in 1899, is still valuable as a repertory of interesting experimental facts as to the pathology of the perceptive and reasoning processes. It should, however, be clearly understood that the general psychological basis adopted by the author consists of doctrines which are now largely antiquated. The doctrine that "ideas" are "revived sensations," and that perception and reasoning are founded upon "association," may now be regarded as practically dead, while the part played in mental life by "fusion" needs to be stated with more accuracy than is shown by M. Binet. And the whole attempt to state the relation between the subject and predicate of a judgment, or the premisses and conclusion of an inference in terms of association, seems to rest upon the common but disastrous confusion of psychology—the study of mental processes—with logic, the study of the laws of evidence.

A. E. T.

Outlines of Physiography. An Introduction to the Study of the Earth. By A. J. Herbertson, Ph.D. Pp. viii + 312. (London: Edwin Arnold, 1901.) Price 4*s.* 6*d.*

WERE it not for the statement at the head of Chapter xxvi., we should not have imagined that this book was intended for the use of students preparing for the South Kensington examination, the ground covered being what is generally regarded as elementary physical geography. The experimental portions of the syllabus, dealing with the physical and chemical properties of matter, are entirely omitted, while other subjects are introduced. Nevertheless, the table of contents indicates a carefully considered classification of the various points to be dealt with, which might have formed the basis of a very profitable course of reading. The subsequent treatment, however, is generally so sketchy that the result will probably be the communication of a number of facts to the reader rather than the enlargement of his powers of observation. A certain amount of carelessness is noticeable in the part which discusses the relation of the earth to the other heavenly bodies. Thus, in Fig. 12, the sun's meridian altitude on March 21 is marked 45°, although there is no reference to the latitude of the place of observation; on p. 31 it is stated that eclipses only occur when the planes of the orbits of the earth and moon coincide; and on p. 34 the obliquity of the ecliptic is not included in the causes affecting the equation of time. The author is much happier in his descriptions of the physical features of the earth and of the causes which mould them, and some of the chapters in this part provide an interesting introduction to various branches of earth-knowledge.

The illustrations are both numerous and good, but the frequent absence of direct references in the text considerably reduces the value of many of them.

Bird Watching. By Edmund Selous. Pp. 337. The Haddon Hall Library. (London: J. M. Dent and Co., 1901.) Price 7*s.* 6*d.*

MR. SELOUS may fairly be called a pioneer. The habits of some few wild animals, such as bees and ants, which can be observed without much difficulty, have been carefully studied; but, except in rare and isolated instances, wild birds have never been made the object of prolonged and patient watching. Since the days of White, Naumann and Montagu, the energies of ornithologists have been devoted rather to problems of classification and distribution than to the "life and conversation" of the birds, and though books by field-naturalists (real and so-called) have been legion, few of them have thrown much light upon problems of animal life and intelligence. Curiosities of bird-life are constantly reported, but the every-day habits of common birds have not been patiently and persistently studied. This work has now been begun by Mr. Selous with admirable accuracy and self-restraint, and his book should have a most wholesome effect on our rising generation of ornithologists, who need to realise that there is a vast field of work still left for them in this country, and that it is not necessary for them to travel long distances in order to make themselves useful or famous.

It is, of course, no easy matter to watch carefully such nervous and restless creatures as birds; a real observer must have both leisure and patience, and must be duly qualified, or train himself to become so, in many other ways. Readers of the *Zoologist* are well aware that Mr. Selous has the necessary qualifications in a high degree, and can have no doubt as to his absolute trustworthiness; and this is everything in a book which is sure to be used by biologists as material for speculation. He has made his notes, for the most part, on the spot, as he watched; where he writes from recollection he is careful to tell us so, and even there we feel that the image left on his mind is clear and strong, just because he sees everything while watching with such an intensity of interest. The notes taken on the spot are often printed *in extenso*, as they were also in the *Zoologist*, and constitute the most valuable part of the book, and it may be hoped that *all* the notes of this kind that he has made may be carefully preserved, whether published or not. But Mr. Selous not unfrequently makes suggestions by way of explaining the phenomena he has observed, and these are always useful and interesting; they are put out tentatively, and the book affords abundant evidence that he does not allow himself to jump at conclusions.

Without anticipating the pleasure or profit which ornithologists and others are sure to gain from the book, it may be said here that Mr. Selous has watched birds courting, dancing, nest-building, feeding, flocking, climbing, singing; and that the range of his studies extends from large birds such as the great skua, the great plover and the cormorants, to the sparrows, chaffinches and blackbirds of our gardens and rickyards. There is a good index, which greatly increases the working value of the volume.

LETTER TO THE EDITOR.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

History as a Science.

THERE have lately appeared in NATURE suggestive summaries of addresses by Sir H. Roscoe, Dr. D. J. Hill and Prof. Ramsay on, respectively, "The Work of the London University," "The Extension of Knowledge" and "The Functions of a University," together with various other papers of an educational character. And to these I would beg permission to add some remarks on the importance of the recognition and endowment, in this country also, of history as a science. Three things are required to make of a body of knowledge a science: (1) verifiability of statements; (2) sufficient length and breadth of survey to make possible the discovery of laws, or verifiable generalisations; and (3) the actual discovery, or an approximation to the discovery, of one or more laws of the facts constituting the body of knowledge considered. But history, as it is commonly studied and taught in British Universities, embraces such brief periods that it can, at best, be characterised only by the most elementary of these three requirements. In geology we have had a science of earth's history since the discovery of the law of the succession of strata. In anthropology we have not, as yet, a science of man's history, seeing that the law of the succession of civilisations has not yet been discovered, or has not, at least, yet been adequately verified. The first object, however, of this letter is briefly to point out that, though the science of man's history would be the most complex of the sciences of evolution, yet the immensely varied results of the researches of the last half, and particularly of the last quarter, of the nineteenth century do bring within the scope of reasonable aims the discovery and verification of general laws of history, with all the incalculable consequences which would therefrom follow in the power given to interpret the past, to guide the present and to forecast the future. And the further object of this letter is to urge that, endowed as the study of history as a science is in all the greater Universities, both of Europe and of America, it should at length be adequately endowed also in British Universities, and more especially in those of Scotland, now so munificently endowed, and whose sons, since Adam Smith, in his "Wealth of Nations," David Hume, in his "Natural History of Religion," and John Millar, in his "Origin of Ranks," have been among the foremost workers and discoverers in this *Scientia Scientiarum*.

But theories of history have also their history. And we may better appreciate the argument for the endowment, at length, of chairs of general history—of history studied with such generality as to make possible the discovery of laws, or, in a word, of history as a science—if we cast a glance on the history of general studies of history during the last century and a half. We shall find it clearly divisible into three periods, on the third of which we are now entering. In all these periods, indeed, two great directions, or rather two great methods of historical research, may be noted—the one synthetic and speculative, the other analytic and inductive. But of the former character was more distinctively the method of the first period, of the latter character the method of the second period, and again, but with incomparably more justification, considering the enormous wealth of facts accumulated in the second period, the third period promises to be, while distinctively synthetic, verifiable in its syntheses.

The first period may be dated from Turgot's second discourse at the Sorbonne, "Sur les Progrès successifs de l'Esprit Humain" (1750), and especially from Hume's "Dialogues on Natural Religion," written about the same time, and his later-written "Natural History of Religion" (1757). This synthetic and speculative era culminated in the philosophies of Hegel and of Comte—for Comte's philosophy is entitled to be called "positive" rather because of its speculative dogmatism than of its inductive verifiability. And around these giants of the forest there grew up such a luxuriance of minor "philosophies of history" as produced a reaction against all general views of history—a reaction from which we, in Great Britain, have unfortunately been the latest to recover.

But among Hume's contemporaries and friends were two masters of the other mode of historical research—the analytic and inductive—Adam Smith and John Millar. From their time to ours the drudging brother has conducted his researches side by side with the high-flying brother, each too apt to sneer at the other, though the function of each was indispensable for the success of the great quest consciously or unconsciously common to both. To the aid of inductive rather than of speculative historical research came, after 1859, the "Origin of Species" year—the immense development of the general theory of evolution which added to the theory of kosmological evolution suggested by Kant and Laplace the theory of biological evolution elaborated by Darwin and Wallace. Simultaneously with the development of this more complex theory of evolution, the researches into man's psychical as well as physical history have had the most fruitful results. And these are now being more and more clearly seen to be contributions to a theory of anthropological evolution which will transform unverifiable, or but partially verifiable, "philosophies of history" into a science of history, conceived at length as the most complex of the verifiable evolutional sciences.

The chief, perhaps, of the contributions to such a science of history may be thus briefly summarised. (1) The ethnological discoveries, which have resulted in a theory of the origins of civilisation in a conflict of higher and lower races. (2) The folklorist discoveries, generalised in a theory of primitive conceptions of nature as conceptions of its solidarity through the interaction and limitless transformation of its parts. (3) The logical and psychological discoveries, which have verified the "Secret of Hegel," or the theory of the process of thought, both individual and historical, as an advance through differentiation to a higher integration. (4) The physical discoveries generalised in the principle of the conservation of energy, and hence in a theory of scientific conceptions of nature as still, even as primitively, conceptions of its solidarity through the interaction of its parts, but now with the profoundly important substitution of the notion of *proved* equivalent, for *supposed* limitless transformation. And (5) the historical discoveries resulting in a theory of civilisation as a process with dateable (as yet no doubt only approximately dateable) beginnings under definable conditions; as a process the astonishing unity of which becomes more and more apparent with the progress of the researches which have demonstrated the derivation, certainly, of Semitic, and, almost certainly, of Chinese, from Chaldean civilisation; the later derivation of Aryan, through Pelasgian, from the connected Chaldean and Egyptian civilisations; and the derivation possibly (as I personally venture to think probably) of the civilisations also of the New from certain of those of the Old World; and, finally, as a process the unity of which further appears in such correlations and synchronisms of development as that illustrated, for instance, in what I have called the moral revolution of the sixth (or fifth-sixth) century B.C., in all the countries of civilisation from the Hoangho to the Tiber, and which has been more and more fully verified since I pointed it out in 1873 ("The New Philosophy of History"). The other theories I have referred to may, or may not, be found fully verifiable. But surely it may reasonably be anticipated that, from consideration of the ever-accumulating facts of these five great classes, we shall sooner or later discover general laws of history—laws of racial evolution, of intellectual development and of social progress—and draw from them results of the highest possible importance for the interpretation of the past, the guidance of the present, and the forecasting of the future?

But, if so, and if I have thus succeeded in showing that the discovery and verification of general laws of history is now brought within the scope of reasonable aims, it should be unnecessary for me to waste many words on the more practical object of this letter, viz. to urge that, endowed as the study of history as a science is in all the greater Universities of our European and American rivals, it should at length be adequately endowed also in the Universities of England, and more especially, perhaps, of Scotland. For, as Lord Rosebery has over and over again said—for instance, the other day (May 15) at a meeting of the University of London—"The struggle of this coming century will not be one so much of brute force as of trained intelligence. . . . No nations are satisfied with the standard of education that prevailed twenty-five years ago. Every nation demands a more keen and more trained and, if I may use the adjective, a more versatile intelligence than that which was adequate for the business methods of the Empire in former days. In other words, we have to meet much keener competition in every department of life. And I hope, though perhaps not with much confidence, that all our educational institutions are recognising that fact and preparing to furbish up their somewhat antiquated methods to meet the demands of modern civilisation and modern competition." And at the same meeting the Vice-Chancellor, Sir Henry Roscoe, said, "If we are to meet successfully the constant changes of thought and manner of life to which a highly-organised society is increasingly liable, our Universities must not be content with giving instruction or testing attainment, however high, but must make real contribution to the knowledge which alone, in some form or other, will be a guarantee of the stability of that society."

I shall only add that the endowment and teaching of history as a science, the most complex of the sciences of evolution, should renew and vivify the teaching of all other sciences. For as the sciences of evolution, the metamorphic sciences as I would call them, are founded on the physical sciences, the ethical sciences are founded on the metamorphic sciences, and especially on that highest and most complex of all these sciences, the science of history, or science of anthropological evolution. More particularly within the scope of the more general or anthropological professorships of history it would come to set forth in their due connection, and in the inferences to be drawn from them, the great, yet hitherto, in this country, hardly known and wholly unappreciated, results of modern research with respect to the origin and history of civilisation. From such chairs also the keynote would be struck which would give a cooperating harmony to the work of every minor chair in the great faculty of history. For a general theory of civilisation, a theory aiming at setting forth the laws of man's history, would touch the whole circle of historical studies. Every special chair, therefore, of the faculty of history would be a centre of fruitful scientific criticism of whatever theory might be put forth from the chair of general history or sociology (if such should be its title). Imagine the result in new knowledge of such an interworking of generalising theory and verifying research! Were the faculties of our Universities, or even of one of them, reorganised as the contemporary development of the idea of evolution demands, what a school of cooperating workers would thus be created! From standing lowest among the great Powers in organisation and encouragement of intellectual work, Great Britain would take her place as highest! "Lords and Gentlemen of England! consider what nation it is whereof ye are, and whereof ye are the governors, a nation not slow and dull, but of a quick, ingenious and piercing spirit; acute to invent, subtle and sinewy to discourse, not beneath the reach of any point the highest that human capacity can soar to." And what lacks there in order to our showing ourselves worthy of this noble adjuration of Milton's but such institutions as our Universities might be if organised, not as I suggest, but as the idea of evolution demands? J. S. Stuart-Glennie.

THE CONGRESS ON TUBERCULOSIS.

The most sanguine expectations of those who have been responsible for the organisation of the British Congress on Tuberculosis could scarcely have led them to anticipate that such a remarkable success would attend their efforts as that which has been achieved. The work of some of these congresses appeals almost entirely to experts, whilst that of others has its interest only for the popular mind. Where, however, such a question as tuberculosis is concerned, the interests involved are so great and far-reaching that the medical man, the dabbler in science and the man in the street are all alike interested and fascinated. From Prof. Koch's splendid address, delivered on the first working day of the Congress, to the practical closing resolutions submitted to the Congress on Friday, those who attended would be ill to please did they not consider themselves provided with subjects for most interesting discussion.

One of the most important items in the success of the Congress was Prof. Koch's address, in which, in masterly fashion, he enumerated the various steps to be taken for the gradual elimination of tubercular process. The very fact that he resiled from one of his original positions—that bovine and human tubercle bacilli are practically identical—aroused such interest that, had no other single subject been discussed, the success of the congress would have been assured, and Prof. Koch is to be congratulated on raising a subject of such vital importance. It cannot but be felt, however, that the experimental evidence on which his opinion is founded is scarcely sufficient to warrant such a sweeping generalisation as that put forward; whilst the clinical evidence brought forward is even less convincing.

The experimental evidence can only be allowed to stand or be controverted on the production of positive evidence that bovine tuberculosis is communicable to man. Such evidence was at once forthcoming, Dr. Ravenel of Philadelphia bringing forward three cases of such infection that had come under his personal observation; one of the patients died, whilst in one more at least the bovine tubercle bacillus was recovered from the local lesion. These cases are, of course, of very great importance, and now that doubt has been thrown on the possibility of such infection, a most careful outlook will, in future, be kept for similar cases. From the clinical side, Prof. Koch's evidence is not convincing, especially as he maintains that no tubercular lesion can be accepted as arising in connection with the intestinal canal in which some effect is not produced on the mucous membrane. It appears to be the experience of pathologists who have examined a large number of cases of abdominal tuberculosis (tabes mesenterica) that a certain proportion, at any rate, whilst showing no local lesions such as ulceration or swelling of the mucous membrane itself, give abundant evidence of invasion of the mesenteric glands, and in a certain proportion of these cases the mesenteric glands only are affected, this proportion ranging from 14 per cent. (Woodhead) to 28 or 29 per cent. (Shennan and Still). Such affection of the lymphatic glands can scarcely be explained on any other assumption than that the infection has taken place from the alimentary canal, whilst there seems to be further collateral evidence that, in some of these cases at any rate, the infective material has been introduced through the agency of cow's milk. So strong is this evidence that most pathologists, on this ground alone, appear to have considerable hesitation in accepting Koch's statements without very careful corroboration, and it is to be hoped that in England, as in Germany and America, the matter will be put to the test as soon as possible. It should be mentioned that Prof. Virchow, one of the greatest authorities on tubercle, is by no means satisfied of the accuracy of Koch's conclusions on this matter. Whatever may be the result of future investigations, however, Prof. Koch may be most heartily congratulated on the courage and lucidity with which he expounded his views and on the interest that he has aroused in the question by the firing off of his bombshell, as it has been called.

The following remarks made by Lord Lister after Prof. Koch's address are of especial interest:—

Lord Lister said the discourse they had listened to was full of profound interest from the beginning to the end. But what had chiefly riveted their attention had been the startling thesis that bovine tubercle could not develop in the human body. This was a matter of enormous practical importance, because, if this conclusion were sound, it would greatly simplify their preventive measures; but it would be a very serious and grievous thing if the rules now in force for securing purity of milk supply should be relaxed and it should turn out after all that the conclusion was erroneous. For his own part he thought the evidence adduced by Dr. Koch to show that human tubercle could not be communicated to bovine animals very conclusive. At the same time he agreed with him that in a matter of such great importance further inquiry was desirable. But even if that were established it would by no means necessarily follow that bovine tubercle could not be communicated to man. He took in illustration the case of variola. Attempts to inoculate human small-pox into the calf had been so very rarely successful that eminent pathologists had concluded that small-pox and cow-pox were two entirely different diseases. We now knew that this was an entire mistake; that cow-pox was small-pox modified by passing through the cow. He referred to some very instructive experiments by Dr. Monckton Copeman, who entirely failed to inoculate human small-pox into the calf, but invariably succeeded in inoculating it into the monkey, and was as invariably successful when he introduced matter from the pustules in the monkey into the calf, the result being ordinary cow-pox which could be used for vaccinating children. It may be that some species of animal may serve as an intermediary host for tubercle between man and the bovine species. Or it may turn out that, if a sufficient number of experiments are made, human tubercle may prove occasionally transmissible to the bovine animal, as small-pox is in rare instances to the calf, and that the bovine tubercle so produced may be transmissible to man, as is the virus of vaccine. The evidence, necessarily indirect, on which Koch relied as showing that bovine tubercle could not be transmitted to man did not seem at all conclusive. It consisted mainly in the alleged rarity of primary tubercular intestinal lesion in children, in spite of the multitudes of tubercle bacilli swallowed by them in milk. Even if it be admitted that primary tubercular intestinal lesions are as rare in children as Koch's statistics indicate, it is certainly true that tabes mesenterica exists in a considerable percentage of children that die of tubercular disease without tubercle being found in any other part of the body. When the mesenteric glands are thus affected without any discoverable intestinal lesion, the natural, and, indeed, inevitable, interpretation seemed to him to be that the tubercle bacilli had passed through the intestinal mucous membrane without causing obvious lesion in it, and had been arrested in the glands of the mesentery. It was known that even typhoid bacilli, whose essential place of development is the intestinal mucous membrane, occasionally pass through it without producing the characteristic lesion. And if this might occur with the typhoid bacilli, how much more likely was such an occurrence with tubercle bacilli! If this be so, Koch's main argument falls to the ground. As regards the experiments Koch had referred to of inoculating bovine animals with material from the glands of children affected with tabes mesenterica, the result being negative, these experiments had been but few; and even were they more numerous, they would not, to his mind, be quite conclusive. It might be that tubercle from milk in the intestines might be so modified by passing through the human subject that the bacilli in the mesenteric glands, though derived from a bovine animal, might be no longer those of true bovine tubercle, but bacilli having the characters of human tubercle little disposed to develop in cattle. The Congress would probably require a more searching inquiry into the subject before accepting this doctrine of the immunity of man to bovine tubercle.

In all other points Prof. Koch, Dr. Brouardel and Prof. McFadyean are thoroughly at one, and they carried with them, by the simplicity and earnestness of their statements, the whole of the members of the Congress, and the effects of their work and observations were plainly manifest in the resolutions that were submitted at the final meeting. These may be summed up in the statement that for the prevention of tuberculosis it is necessary to attend to the housing of the people, to the provision of a sufficient supply of fresh air, as good nutrition as possible, and to the prevention of the dissemination of the tubercle bacillus (for which purpose proper precautions should be taken to have it collected and destroyed as soon as it comes from the patient); for the cure of consumption fresh air, good food and well-regulated exercise; whilst in regard to bovine tuberculosis there seems to be no difference of opinion that, until the question raised by Prof. Koch is finally settled, no relaxation of the methods at our disposal for the examination and confiscation of tuberculous meat and milk should be allowed.

The work of the sections was, of course, somewhat more specialised in character. The report of the combined discussion on tuberculin will direct attention to the advantages and disadvantages claimed for and against the use of this therapeutic agent. Other methods of treatment also received full attention in Section I (Medicine).

In Section II. (Preventive Medicine) preventive measures were fully discussed, and the number of papers brought forward and dealt with give ample evidence of the interest taken in the work of this section.

In Section III. (Pathology and Bacteriology) some of the most useful work that came before the Congress was discussed. We would specially refer to Prof. Benda's paper on the channels of spread of tuberculosis and Dr. Ravenel's paper on the relation of bovine to human tuberculosis. This latter paper was exceedingly well-timed from the fact, already mentioned, that the author had to record three cases of infection of the human subject by bovine tuberculosis.

In Section IV. (Veterinary Section) an exceedingly interesting series of papers was discussed, especially one dealing with the application of tuberculin to cattle supplying milk. In connection with this, Prof. Bang pointed out that tuberculous animals might have non-tuberculous lesions of the udder; but, if there was any suspicion of tuberculosis of the udder and the animal was otherwise tuberculous, the benefit of the doubt should always be given in favour of the consumer, and the lesion should be looked upon, temporarily at any rate, as of a tubercular nature, and the necessary precautions should certainly be taken. Where, however, it could be proved that the lesion was non-tuberculous he thought that the milk might sometimes be used, if proper precautions were taken; though we should imagine that most people would consider the proper precautions in such a case would be absolute sterilisation of the milk.

As proof of the great interest taken by the King in the work of the Congress, His Majesty received a number of the foreign delegates in the Throne Room at Marlborough House. The delegates were accompanied by the Earl of Derby, Sir William Broadbent (chairman of the Organising Committee), Prof. Clifford Allbutt (regius professor at Cambridge and chairman of the General Purposes Committee), Mr. Malcolm Morris (honorary secretary-general of the Congress), and Dr. St. Clair Thompson (honorary financial secretary of the Congress). The following delegates were presented by the Earl of Derby, but Dr. Koch, who had promised to open a discussion at Eastbourne, and a few other foreign delegates were unable to be present:—Prof. Osler and Prof. Janeway, United States; Hofrath Prof. von Schrötter and Prof. Dvorak, Austria; M. le Sénateur Montefiore Lévi and Dr. van Ryn, Belgium; Dr. Mickailovsky, Bulgaria; Prof. Bang and Dr. Charles Gram, Denmark; Dr. Brouardel (Doyen de la Faculté de Médicine de Paris), Prof. Bouchard and Prof. Nocard, France; Geheimrat Prof. Gerhardt, Prof. Flügge, Geheimrat Prof. von Leyden, Prof. Fraükel, Dr. Werner and Dr. Dettweiler, Germany; Prof. Thomassen, Holland; Prof. Koranyi, Hungary; M. Malm, Norway; Prof. da Silva Amado, Portugal; Señor Don Antonio Espina y Capo, Spain; Hof-Marshal Printzjold, Sweden; and Dr. Neuman, Switzerland. His Majesty shook hands with each delegate as he was presented, and then said:—

"GENTLEMEN,—Let me express to you the great pleasure and satisfaction it has given me to ask you to come here to-day; I only regret that you should have arrived during such a severe thunderstorm. It has been a source of great concern to me that, owing to circumstances over which I had no control, I was prevented from presiding at the opening of your important Congress and attending its meetings; but I can assure you that, though not present, I take the deepest interest in its proceedings, and that I follow with much interest, through the medium of the daily Press, the papers which are read and the discussions on the subject. There is no more terrible disease than that known as consumption, and I only hope and trust that you may be the means of minimising its evil effects, and thereby receive the gratitude of the whole world. There is still one other terrible disease which has up till now baffled the scientific and medical men of the world, and that is cancer. God grant that before long you may be able to find a cure for it, or check its course; and I think that to him who makes the discovery a statue should be erected in all the capitals of the world. In taking leave of you I trust that your stay in London and in England has been an enjoyable one, and that you will one and all carry away pleasant recollections of your visit to my country."

There can be no doubt that the King's desire will be gratified, for, if the foreign delegates have received the some amount of pleasure from the scientific and social work of the Congress as have their British *confrères*, they should go away amply satisfied and with very pleasant recollections indeed. That they were prepared to enjoy everything may be gathered from the fact that they cheerfully, and apparently even willingly, sat through twenty-seven speeches at the final banquet given on Friday night.

The other social features of the Congress were the receptions at the Mansion House by the Lord Mayor, at Apsley House by the Duke and Duchess of Wellington, at the Victoria and Albert Museum by the Earl and Countess of Derby, and at Sion House by the Duke and Duchess of Northumberland; whilst evening parties, private dinners, water parties and the like afforded ample entertainment for all who were able to attend such functions.

Altogether the Congress may be looked upon as one of the most interesting and successful ever held in London, and the results promise to be very far-reaching.

POSITION AND PROSPECTS OF ELECTRO-CHEMICAL INDUSTRIES.

THE presidential address delivered last week by Mr. J. W. Swan, F.R.S., to the Society of Chemical Industry, though it covers the same ground as the one he delivered three years ago as President of the Institution of Electrical Engineers, does so in a much more comprehensive and detailed manner. The paper is very valuable and instructive, though not always pleasant reading for the English electrochemist, who cannot help reflecting that his country is much behindhand in the development of those industries of which Davy and Faraday laid the foundations. It cannot be urged that our backwardness is wholly due to the lack of water power in the British Islands, though doubtless this has contributed in many instances to our failure to keep pace with our competitors. But there are many electrochemical industries in which, though cheap power is by no means essential, other nations have been the pioneers and are likely to reap the reward. Thus, to quote one striking example, there appears to be no English bullion refinery using electrochemical processes, although these are finding extensive employment in America and Germany. The value of the output for 1900 from two out of the three German refineries is given by Mr. Swan as 2,500,000*l.*, the source of power in all three cases being steam.

The fact remains, however, as Mr. Swan points out, that the greater number of electrochemical plants are operated by water power. For fifty European works the figures obtained show that there is 149,000 h.p. available from water, 16,700 h.p. from steam, and 250 h.p. from gas. The great bulk of the horse power generated from water is used in the production of aluminium and calcium carbide, industries in which cheap power is paramount. Is it to be feared, therefore, that the more extended use of electrochemical processes will cause chemical industries to leave this country for others more fortunately supplied with waterfalls? The question is one, as Mr. Swan says, "of national importance, for chemical manufactures occupy, and have always occupied, a leading place among the industries of our country." Something, perhaps much, is to be hoped for from the reduction in the cost of power generated from coal, in which connection we may quote Mr. Swan's words:—

"Great advances have in recent years been made in the direction of reduction of cost, by improvements in the steam engine, the gas producer and the gas engine. In the best modern steam engines a heat efficiency of 15 per cent. is obtained. There is great reason for hope that help in the more economical generation of power for electrochemical work may come from the further development of the gas engine. Already much has been done, both in the improvement of the gas engine and also in providing it with cheap gas. Our honoured past president, Dr. Mond, has made a valuable contribution in this direction.

"One of the drawbacks to the employment of gas engines for large operations has been that they were not adapted for large units of power, but now engines of 500 h.p. and even 1000 h.p. are manufactured, and work with successful results."

It is to be feared, moreover, that we are not only hampered by unfavourable conditions, but that we do not make the most of the opportunities we possess. The position deserves the most careful consideration of all chemists and electricians, or the former will one day awake to find that his purely chemical manufacturing processes have been superseded in other countries by electrochemical methods, and the latter will find, as he has already found largely in electric traction, that, whilst he was sleeping, a new field of development has been fully exploited by American and continental engineers. We cannot help thinking that the fault is, to a considerable extent, due to our educational system and to the bias of the English manufacturer against college-trained men. Mr. Swan's remarks on this point are worthy of very careful attention:—

"In England and Ireland we are suffering acutely from dire educational neglect and destitution, and that worst kind of poverty, *insensibility to our deficiencies.*

"Our English system of scientific and technical education is not equal to the present needs of the country, seeing how severely we are pressed on every side by the most energetic and intelligent competition. We are giving to the classes at the bottom of the industrial ladder a disjointed smattering of miscellaneous science, of no great value, though probably good so far as it goes, while we are neglecting to educate thoroughly those upon whose shoulders will soon rest the weight of the management of our great manufacturing industries. In the present state of things a competent knowledge of the science of the business a man is engaged in, as well as an active interest in it, whether it be chemical industry or any other, are essential conditions of any large degree of success in meeting the emergencies of a highly competitive and progressive time. A scientific training of university standard, for our manufacturers and for our technical chiefs, is an absolute necessity. Surely public money cannot be better spent than in providing adequate facilities for the educational equipment of the men of the future, with this essential means of national defence. Our country possesses great stores of mineral wealth, a precious heritage that we are lavishly spending. That gift of nature will certainly not avert, and cannot go far to compensate for, the consequences of neglect of the scientific training necessary to turn our fast-diminishing mineral wealth to the best advantage.

"One of the most pressing requirements of the moment, demanded, not only in the interest of chemical industry, but in that of our manufacturing industries generally, is *adequate endowment and encouragement of research.* Original scientific research is the fountainhead of new knowledge, the vital stimulus of industrial growth, the originator of new industries and sustainer of old. Yet, nationally, in the organisation of our educational and industrial system, we give to scientific research no hospitality—we barely pay it the respect of recognition."

These arguments have been advanced again and again by educational enthusiasts, but they have as yet borne but little fruit. Perhaps now that they have been so strongly endorsed by one so well qualified to speak from the manufacturer's point of view as Mr. Swan, they may find their way into the minds of those in whose hands lies the future industrial prosperity of England.

MISS ELEANOR A. ORMEROD.

UNIVERSAL regret will be felt at the death of almost our only prominent lady entomologist, and our best authority on farm and garden entomology. Miss Ormerod was born at Sedbury, in Gloucestershire, and breathed her last on July 19, 1901, in her seventy-fourth year, at Torrington House, St. Albans, where she resided for some years with her sister, Miss Georgiana Elizabeth Ormerod, who died in 1896 at the age of seventy-three.

At the time when Miss Eleanor Ormerod turned her attention to injurious insects, no popular English work existed on the subject; for Curtis's "Farm Insects" was too large and costly for wide circulation. We do not know if Mr. E. A. Fitch, who had been projecting a work on the subject himself, suggested it to Miss Ormerod, or whether the initiative came from her; but in 1877 appeared the first part of the well-known "Notes of Observations of Injurious Insects," by E. A. Ormerod, T. A. Preston and E. A. Fitch. About this time Mr. Fitch found that pressure of business prevented him from giving much attention to entomology; but for twenty-three years afterwards appeared annual reports, under the editorship of Miss E. A. Ormerod, embodying the observations of a great number of observers on those species of insects which had been most destructive, or which had attracted special attention during each year. From time to time she published detached observations in different journals on subjects of much importance connected with her favourite subject, supplementary or preliminary to her reports, and she also published several books which had a wide circulation, and some of which went through several editions. Among the most important of her separate works are the following:—"A Manual of Injurious Insects, with Methods of Prevention and Remedy for their Attacks to Food Crops, Forest Trees and Fruit, and with short Introduction to Entomology" (first edition, 1881); "Guide to Methods of Insect Life, and Prevention and Remedy of Insect Ravage" (1884); republished in 1892 under the title of "A Text-book of Agricultural Entomology"; "Notes and Descriptions of a few Injurious Farm and Fruit Insects of South Africa, compiled by E. A. Ormerod, F.R.Met.Soc., &c., with Descriptions and Identifications of the Insects by Oliver E. Janson" (1889); and "A Handbook of Insects injurious to Orchard and Bush Fruits, with Means of Prevention and Remedy" (1898).

Miss E. A. Ormerod was assisted in her work by her sister Georgiana, who was likewise an ardent entomologist, though we are not aware that she ever published anything under her own name. Both the sisters were Fellows of the Entomological Society of London, having joined in 1878 and 1880 respectively, and at one period they were regular attendants at the meetings. For some years Miss E. A. Ormerod held the appointment of consulting entomologist to the Royal Agricultural Society. She was also an examiner in agricultural entomology to the University of Edinburgh; and in 1900 that body conferred upon her the honorary degree of D.C.L.

W. F. K.

NOTES.

THE French Minister of War has asked the Paris Academy of Sciences to give an opinion as to the possibility of danger arising from the establishment of wireless telegraphy stations in the neighbourhood of magazines containing powder or other explosives. It is suggested that the nature of the cases containing the explosive may be an important matter for consideration in connection with the subject.

THREE prizes have been offered to the Marine Biological Association of the West of Scotland by Sir John Murray, K.C.B., in memory of the late Mr. Fred. P. Pullar, who was associated with him in the bathymetrical survey of the Scottish fresh water lochs, and lost his life on Airthrey Loch, Bridge of Allan, in February last. There will be a prize of 50*l.* for a paper on each of the following subjects:—(1) The seasonal distribution and development of pelagic algæ in the waters of the Clyde sea area. (2) The reproduction, development and distribution in the Clyde sea area of the genera Nyctiphanes and Boreophausia. (3) The formation and distribution of glauconite in the deposits of the Clyde sea area and the adjacent seas of Scotland. These prizes are open to investigators from any part of the world who conduct observations in the several subjects at the Millport Marine Station, and who produce, at any time before January 1, 1905, papers which, in the opinion of a committee of three scientific men, to be nominated by the committee of the Association and by Sir John Murray, shall be deemed of sufficient value to merit publication. The honorary secretary of the Association is Mr. John A. Todd, 190, West George Street, Glasgow.

THE annual meeting of the British Medical Association was opened at Cheltenham on Tuesday, when Dr. G. B. Ferguson, the president, delivered an address on "Scientific Research as the Indispensable Basis of all Medical and Material Progress." In the course of his remarks, Dr. Ferguson said that medical progress owed more to the biologists and to the men of pure science than to the so-called practical men. The cell theory, for instance, originated entirely with the biologists. It led up to bacteriology, the most imposing and the most impressive department of medical biology. Bacteriology itself now rested on cultivation and staining; and if year by year more and more of the germs of disease were recognised, it was because of the improved methods of colouring and making them visible. All this strengthened his contention that the basis of modern medicine was essentially scientific. Then in surgery the discovery of the Röntgen rays had been of priceless benefit, but most certainly Röntgen was thinking of nothing less than of surgery when he made that discovery. Antitoxins, which are among the most valuable resources of remedial art, medical men owed to strictly scientific investigators. Personally, he placed much faith in the anti-typhoid inoculations of Prof. Wright, of Netley, and in the anti-tetanus serum, and he felt sure that many more equally effective means would soon be available. Dr. Ferguson next recalled the splendid work—purely scientific again—of the French and Italian investigators of malaria, together with Major Ronald Ross, Dr. Manson, and other English observers, by whom the mosquito theory had been worked out. Turning to ophthalmology, he asked what would have been its state to-day without the invention of the ophthalmoscope by the physicist Helmholtz. Then there was the marvellously successful treatment of lupus by the chemical rays of the electric arc devised by Finsen, of Copenhagen. And where would medical men be without the chemists, who had provided iodine, bromine, iodoform, chloroform, chloral and cocaine? As the result of several visits to the continental capitals he had been struck with the thoroughness and scientific spirit everywhere there manifested, very different from the anti-scientific spirit characterising most of the wealthier and more cultivated classes in this country. France, Germany and the United States educated at their Universities approximately one student in every 1500 of the population, but we were content with less than one in 2000. Yet the matter was one of life or death for the country, for more and more every year the victory and the predominance would pass to the possessors of the latest knowledge, the deepest science and the most perfect and economical processes.

THE Harben medal of the Royal Institute of Public Health was presented to Prof. Koch at the annual dinner of the Institute on July 24. The medal is awarded in recognition of services rendered to the public health, and is conferred irrespective of nationality. In presenting the medal, the president of the Institute, Prof. W. R. Smith, described Prof. Koch's career of scientific activity. In reply, Prof. Koch remarked that when, as a young doctor, he went to take up his practice at Wallstein he found himself in a country where anthrax was to be seen on every hand, and he was naturally led to make the matter one of research. In that research he was greatly assisted by the perfection to which the microscope had been brought, and this gave the key to the wider discoveries in bacteriology that followed. He was gratified to receive the medal as a testimony of their concurrence with the scientific methods which he had followed, and he was all the more pleased to have such an honour from an English institute, because it was in England that his researches in reference to anthrax and the treatment of wounds met with the first appreciation.

PROF. W. A. HERDMAN has received letters and natural history notes from Mr. Nelson Annandale and Mr. H. Robinson, who left Liverpool University College a short time ago for a year's exploration in the Siamese Malay States. Some of the observations made and material collected will be described at the forthcoming meeting of the British Association at Glasgow. Meanwhile, it is interesting to read the following notes from the naturalists:—"We have obtained what is either a second species of Periophthalmus or a genus closely allied to it, and we have to-day ourselves collected a series of young specimens, which show that in extreme youth the eyes are normally placed on the sides of the head, and only migrate to the top later in life. We also got in water less than a fathom a most interesting case of commensalism, in which a small crab, with a very soft back, has the two last pairs of legs specially modified for holding on a sea-anemone, which it grasps by the foot. . . . A good many cases of mimicry between different orders and families, principally between spiders and ants, homoptera and beetles, were noted—in at least ten cases the mimicked animal being an ant."

THE programme of the seventy-third meeting of German Men of Science and Physicians, to be held at Hamburg on September 22-28, has been issued. As there are eleven sections dealing with different departments of natural philosophy, and twenty-seven sections in the group of medical sciences, it is easy for all who are engaged in scientific work to find a section in which they are particularly interested. The general science sections are:—(1) mathematics, astronomy and geodesy; (2) physics, including instrument making and scientific photography; (3) mixed mathematics and physics (electrotechnics and scientific engineering); (4) chemistry, including electrochemistry; (5) general chemistry, including agricultural chemistry and food investigations; (6) geophysics, including meteorology and terrestrial magnetism; (7) geography, hydrography and cartography; (8) mineralogy and geology; (9) botany; (10) zoology; and (11) anthropology and ethnology. On September 23 and 27 there will be general meetings at which lectures will be given. On the former date the lectures to be delivered will be on Hertz electric waves and their further development, by Dr. E. Lecher; the chemical possessions of the cell, by Dr. F. Hofmeister; and the problem of fertilisation, by Prof. T. Boveri. On September 27 the lectures will be on medicine and maritime intercourse, by Prof. H. Curschmann; the significance of electrical methods and theories in chemistry, by Prof. W. Nernst; and on the natural energy of organisms, by Prof. J. Reinke. There will be a joint meeting on September 25 for the discussion on atoms, from the point of view of recent investigations and conclusions on ions and electrons. The president of the meeting is Prof. R. Hertwig, of Munich. Prof. van 't Hoff is the president of the group of natural philosophy sections, and Prof. Naunyn the president of the sections of medical sciences.

THE presidential address delivered by Mr. G. C. Druce at Dublin on Tuesday, at the opening meeting of the British Pharmaceutical Conference, was a survey of the important scientific discoveries made during last century, and their relation to the art and practice of pharmacy. In pharmaceutical chemistry, the active principles which have been isolated are now appalling in number, and have assisted in making great changes in the character of dispensing. In addition, a stream of artificial compounds, many of which possess marked therapeutic action, has flowed from the laboratory of the chemist. Referring to botany and systems of classification, Mr. Druce said: "One marked change has taken place during the past century so far as the professional teaching of botany is concerned, for in the early years of last century all the important botanical chairs in Britain were held by systematists, now not a single one is so occupied. This is not an unalloyed advantage. That systematic botany alone should be taught to the almost absolute neglect of histology or physiology was doubtless an evil, and it has been said that taxonomic teaching was choked by its own nomenclature; but the whirligig of time brings its revenges, and now we may without injustice retort that laboratory botany is being strangled by the exuberance of its terminology. And the positive evil exists that with the neglect of systematic teaching in Britain our continental and transatlantic *confrères* are occupying the ground in which Britain for long held a foremost position, and which, from the extent of our colonial possessions, should be especially its own."

DR. CARL PETERS has returned to London, after an extended journey from the Zambesi to the Sabi rivers, and has brought home news of interesting archæological discoveries on the frontier of Mashonaland. One of these is a small female figure of Egyptian workmanship, which is believed to date back to 2500 years before the Christian era. There have also been found thirty-three copper and six silver coins and a couple of stones bearing inscriptions. It is hoped that a scientific expedition will be sent out to make further investigations.

WE learn from the U.S. *Monthly Weather Review* that the German South Polar Expedition will systematically make kite ascensions in the trade winds from aboard ship during the southward journey, and continue the work in the Antarctic regions. The expedition is fully equipped with suitable apparatus, all substantially of the Weather Bureau pattern, and the scheme will be that followed at Washington, with modifications required by the conditions and resulting from extensive experiments at the Deutsche Seewarte. The kites are of three sizes, the large Marvin of $6\frac{1}{3}$ square metres surface, Hargrave kites of 4 and $2\frac{3}{4}$ square metres surface and light Eddy kites of $2\frac{3}{4}$ square metres, which are very advantageously employed in lifting and sustaining the larger kites with the instruments in light winds. This appears to be the first occasion on which preparations have been made for the systematic exploration of the upper air conditions in the polar regions.

AFTER a protracted spell of dry weather, London was visited by a violent thunderstorm about noon on July 25. The weather chart issued by the Meteorological Office on that day showed that a shallow depression lay over the south-eastern parts of England, and this moved very slowly to the westward during the next few days. Except that the conditions were very unsettled there was nothing to indicate the occurrence of a storm of unusual violence. The rainfall was of great intensity, amounting to nearly an inch and three-quarters in about an hour and a half, and to three inches within forty-eight hours. In some parts of the metropolis much damage was caused by flooding, and railway traffic was suspended for a considerable time. As late as Sunday last this same shallow storm area was still lingering over the southern portion of the country, the centre being in the morning in the south-west. Heavy thunderstorms were still occurring in those parts which lay near the path of the disturbance. On Saturday there was again exceptionally heavy rain in parts of London, an inch falling in less than an hour in the southern suburbs. The midland districts of England have experienced very heavy rains, the fall at Oxford amounting to 4·33 inches in the four days ending last Sunday morning.

WE have received from Dr. W. Doberck, director of the Hong Kong Observatory, a copy of the observations made there during the year 1900. The work contains, in the same form as in previous years, a very valuable series of hourly meteorological observations and mean results deduced from them, as well as magnetical and astronomical data. In addition to the usual work of a well-equipped observatory, much attention is given to various researches, including the collection of observations at about forty land stations and from ships' logs, with the view of contributing to our knowledge of the climatology of the Far East and of the destructive typhoons of the eastern seas. The total number of days' observations collected from different ships during the year amounted to nearly 20,000; these are regularly entered in degree squares for the construction of trustworthy pilot charts. Weather forecasts are also issued daily about 11h. a.m., and a comparison with subsequent weather shows that the amount of total or partial success reached the high figure of 93 per cent. during the year in question.

THE Meteorological Office Pilot Chart of the North Atlantic and Mediterranean for the month of August shows that there has been a very decided increase in the quantity of ice in the neighbourhood of Newfoundland, the reports, which are as late as July 3, being too numerous to admit of all being given on the chart. The bergs crowd mostly from Cape Race eastward to the Flemish Cap, but there are a good many scattered about down to 42° N., 49° W. and 43° N., 43° W. In the notes on the winds, further information is given relating to West Indian hurricanes, some of which, there is reason to believe, originate in the neighbourhood of the Cape Verde Islands, where the prevailing winds for August exhibit a cyclonic circulation. To the mean path of these hurricanes is added an indication of the southern and the eastern and northern limits within which they have been experienced in this month, the South American coast westward to Honduras being practically free from actual hurricanes, but experiencing very disturbed seas, occasioned by the distant gales. In Trinidad, the hurricane months are marked by violent squalls and heavy rain. The region of ordinary gales has commenced to work southward after having nearly disappeared northward in July. After steadily extending eastward from the American coast until the Bay of Biscay was reached in July, the fog area has suddenly shrunk, the main area being now to the westward of the 30th meridian, only a small patch being shown off the English Channel; but it is stated that while there is this diminution off our south-western coasts there is an increase in progress up the east coast of Britain and about the Clyde and Irish Sea. Other notes deal with the salient features of the ocean currents; with British thunderstorms which form locally; and with the winds of the Sea of Marmara, and currents of this sea and the Dardanelles and the Bosporus.

THE Report of the Council issued in the *Proceedings* of the South London Entomological and Natural History Society for 1900 discloses a satisfactory state of the roll of members and of the finances of that energetic body. The average attendance at the meetings has been about 30, which is remarkably good for a society whose members number only 170. Mr. R. Adkin communicates an interesting article on the life-history of the goat-moth, in which it is shown that the change from caterpillar to chrysalis does not take place in the stems of the living willows tunnelled by the former, but rather in dead trunks or any other situation where soft, friable matter is to be met with.

A VIEW of M. Fagel's statue of Chevreul, unveiled at Paris on July 11, is given here by the courtesy of the *Chemist and Druggist.* The monument stands in the Cour d'Honneur of the Paris Museum of Natural History, and is an excellent representation of the eminent chemist, whose investigations have greatly assisted in promoting the commercial prosperity of France. The base of the statue bears inscriptions recording the principal events of Chevreul's life, the front one being as follows:—"Chevreul, Michel-Eugène, né a Angers le 31 aout 1786; mort a Paris le 7 Avril 1889. Professeur de Chimie

Statue of Chevreul.

Organique, 1830–1889; Directeur du Muséum d'Histoire Naturelle, 1863–1884." Upon the occasion of the unveiling of the statue, M. E. Perrier, the present director of the Paris Museum of Natural History, delivered an address which is given in full in the *Revue Scientifique* of July 20, with discourses by M. A. Gautier, who represented the Academy of Sciences, and M. Arnaud, who succeeded Chevreul in the chair of organic chemistry at the Museum in 1890.

THE latest issue of *Notes* from the Leyden Museum contains an article by Dr. F. A. Jentink on the collection of antelopes in that institution, in the course of which the author pays a tribute to the value of the "Book of Antelopes," by Messrs. Sclater and Thomas. The Leyden collection appears to be very rich in antelope skins from the Cape, many of these belonging to species which are at least locally extinct. The author believes the white-tailed gnu to be quite extinct as a wild species, and the same is true for the eland in Cape Colony. The head of a female of the latter with an abnormal form of horn is figured. In the same journal Dr. Finsch continues his catalogue of the Leyden bird collection, dealing in this section with the bee-eaters.

ANOTHER ruminant—the Louisianian representative of the white-tailed deer—receives a new name in the June number of the *American Naturalist.* Recently some American writers announced that the proper specific name of the Virginian white-tail was *americanus*, instead of the time-honoured *virginianus*, and the former name has consequently been generally adopted in literature. Others say they were wrong in the change, and propose to revert to *virginianus.* Nothing can be more unsatisfactory than such perpetual changes, and it is far better to adhere to one name, even if it be not what is called the right one. To the same journal Dr. R. W. Shufeldt contributes a paper on the affinities of the American birds commonly known as screamers (Palamedeæ). While admitting their affinity with the duck tribe, he suggests that they may be the survivors of the common ancestral type of both the anserine and the gallinaceous birds. In all their characters these birds are archaic, and the author is of opinion that they serve to connect the duck tribe with the ostrich group.

IN launching a new periodical, the *Museums Journal*, of which the first number is dated July, the Museums Association has full justification, and the venture has our best wishes. It is edited by Mr. E. Howarth, of Sheffield, with the cooperation of other museum officials from England, Germany, the United States, Australia, the Cape and New Zealand; and by this wide basis any danger of cliquism gaining a predominance in the new journal should be obviated, while it will ensure attention to the needs of museums in all parts of the world. Following the introductory notice is an address on the museums of Edinburgh by Sir William Turner, the president of the Museums Association, whose portrait forms the frontispiece to this issue. Next comes a specimen museum label, to be followed by others month by month. This label, which deals with British pottery, is, in our opinion, too long and too verbose. In order to avoid wearying museum visitors, it should clearly be divided into two—the first descriptive and the second dealing exclusively with the various British potteries. The part closes with a series of general notes, of which one section is devoted to home and the other to foreign museums.

SOME interesting conclusions have been arrived at by Dr. Ford, of the McGill University, Montreal, in the course of his investigations on the bacteriology of the healthy organs of animals. The liver and kidneys of a number of rabbits, guinea-pigs, cats and dogs were examined, and at least eighty per cent. were found by Dr. Ford to contain bacteria. This is contrary to the results obtained earlier by Neisser and Opitz, who in similar examinations found no bacteria. This apparent discrepancy in the two series of investigations is explained by Ford as due to Neisser and Opitz only cultivating the organs examined by them for two, at most three, days, whereas it is necessary, Ford states, to leave them for several days, a week, and even two weeks to obtain the development of the bacteria present. Each animal, regardless of its species, showed its distinct bacteriology, and as a rule the Carnivora—dogs and cats—exhibited bacteria similar to each other, but absolutely different from those obtained from the Herbivora—rabbits and guinea-pigs. These results are quite consistent with the difference in the food used by the animals, which would determine to a large extent the intestinal flora. Dr. Ford's paper is published in the *Transactions* of the Association of American Physicians.

The *Revue générale des Sciences* for June 30 and July 15 contains an article by Dr. Cureau on the geography of equatorial Africa. The subject is well treated in its most general aspects, and a number of interesting sections, particularly of the Nile-Congo region, are given. The second article deals with the population.

THE new number of the *Mitteilungen aus den deutschen Schutzgebieten* contains two important series of determinations of heights in Togoland. Dr. A. Lübbert contributes a paper on native treatment and medicines in German South-west Africa, and a report on the system of land surveying employed in Cape Colony and its application in modified form to German South-west Africa. From German East Africa Captain Prüssing writes on the Rufiyi delta, and Dr. Kandt on Ruanada. Dr. Pflüger contributes some notes on the geology of the Bismarck Archipelago.

The *Zeitschrift* of the Berlin Gesellschaft für Erdkunde contains an important report by Dr. von Oppenheim on his journey in Asiatic Turkey during 1899. The region traversed is of special interest in relation to the proposed railway from Constantinople to Bagdad, and the paper discusses the best available route for such a railway, and the prospects of its financial success. Dr. W. Brennecke gives, in the same number of the *Zeitschrift*, the results of Prof. Philippson's determinations of heights in the neighbourhood of Pergama.

In *Petermann's Mitteilungen*, M. Gentil-Tippenhauer continues his papers on the geology of Haiti. The present instalment deals with the mineral deposits of Terre-Neuve and Gonaives. Prof. Supan contributes a paper, read at the recent Geographentag at Breslau, on the climate of the Antarctic, in which he discusses the results of recent observations as establishing the existence of a permanent polar anticyclone, surrounded by a ring of low pressure. Dr. Franz Schaffer gives an account of studies in the geotectonics of south-eastern Anatolia, made during journeys in the spring and autumn of 1900.

THOSE of our readers who are interested in the Farthest East should consult the *Mittheilungen der deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens* (Tokyo, also at Asher and Co., Berlin). In vol. viii. part 2 of that journal will be found an account of the existing and proposed state and private railways in Japan, by Inspector F. Baltzer. The ancient national bon-festival is described by Dr. H. Weipert and illustrated by nine plates drawn by Japanese, which present existing and former aspects of certain ceremonies and dances connected with the festival. The bon-dance has been handed down from the mythical period, and the primitive Ainos have a very similar dance. The Rev. A. Lloyd has a paper, in German, on dogmatic anthropology in Buddhism. Prof. Aoyama writes on the plague. The number concludes with a short communication by Prof. Dr. E. Bälz on the racial elements in Eastern Asia, especially in Japan. He characterises (1) the Mongolo-Malayan type; (2) the Korean-Mandschurian type; (3) the Aino type. The latter are, according to Bälz, the remains of a "Caucasian or Caucasoid race" that was widely scattered throughout the whole of the north of Asia.

THE current volume (vol. iii.) of the *Bulletin* of the Free Museum of Science and Art of the University of Pennsylvania has several interesting articles, mainly on collections that have been presented to the Museum. We have previously directed attention to this Museum, which has greatly prospered under the curatorship of Mr. Stewart Culin, and is rapidly becoming an important centre of research and instruction. A copiously illustrated account is given by Mr. Culin of a summer trip among the Western Indians, being a narrative of the Wanamaker Expedition. In addition to much interesting information gained on this trip, large numbers of specimens were obtained, many of which were of objects the use of which has all but died out. Pendant-shaped stones with a groove encircling one end are constantly found in America in graves and elsewhere. These are popularly called "plummets." The so-called "plummets" form the subject of an illustrated paper by Charles Peabody, who enumerates the numerous uses to which these stones have been supposed to be put. Of these supposititious uses that as true plummets is the most unlikely; probably most were sinkers used in fishing and some were weights used in weaving, while others were probably used for various purposes. The indefatigable travellers, Dr. H. M. Hiller and Dr. W. H. Furness, 3rd, give an illustrated paper on the Veddahs of Ceylon, but there is nothing particularly new in their observations. The games of the Ogalala Indians are fully described by Mr. Louis L. Meeker; these Amerinds are a branch of the Sioux, and the specimens he collected further enrich the unique collection of toys and games that Mr. Culin has been the means of garnering in the Museum under his care.

AMONG the series of useful French handbooks published under the title of *Scientia*, there are few that will prove of greater interest to mathematicians and physicists than M. J. Hadamard's volume of 102 pages on Taylor's series and its extension. The general problem of Taylor's series consists in the determination of an analytical function by the solution of the following problems: (1) calculation of the function at any point whatever; (2) determination of the singular points. M. Hadamard considers that the solution of the first problem is to be found in Mittag Leffler's theorem, but that of the second is at present in a much less advanced stage. In the bibliography, the author gives a list of more than a hundred books and papers dealing with the properties of analytic functions, the convergence of series and other questions arising out of the general problem.

IN the *Psychological Review* (viii. 2), Prof. G. T. W. Patrick studies the questions, "Why do men swear? When they swear, why do they use the words which they do?" From a classification of the various forms of profane expression used by men at different periods of history, and an examination of their connection with religious words, the writer concludes that profanity is not to be regarded as primarily an expression of emotion, but is only to be understood by the genetic method, the point of departure being the growl of anger in the lower animal, which is a serviceable form of reaction in cases of combat. It belongs, therefore, to a primitive form of vocalisation, and hence is ancient and deep-seated, being one of several forms of speech preceding articulate language by an indefinite period of time. By a process of selection it chooses at all times those forms of phonation or those articulate words which are best adapted to terrify or shock the opponent. Although originally useful in combat, the occasion of profanity at the present time may be any analogous situation in which our well-being is threatened, as in helpless distress or disappointment. If, then, the oath is a form of instinctive reaction and even a purifying agent, why is it considered to have an immoral quality? Prof. Patrick thinks for two reasons: first, because advancing civilisation bids us evermore inhibit and repress; and, secondly, because of the unfortunate but inevitable connection between profanity and the sacred names of religion.

AN account of the new eruptive cone on Vesuvius, which commenced to form in September, 1900, up till April last, is given by Prof. E. Semmola in the *Rendiconto* of the Naples Academy (vii. 4). The cone is—or rather was at that time—about forty metres high, but difficult of ascent owing to its steepness and the thick coating of sand on its walls. The internal cavity was irregularly elliptic and was divided along its major axis into two parts. In that part lying towards the north-east a crater had been formed whose depth did not appear to exceed twenty-five metres; at its bottom was the eruptive aperture emitting a copious column of vapour and gas. In the smaller portion was a crateriform dyke, full of cracks, and with the walls smoking in places, this being separated from the crater previously mentioned by a kind of wall rising half-way up and terminating in the floor of the crater. The internal walls of the crater were carpeted with sublimates, in which various shades of red and yellow predominated. The vapour made its exit in globular clouds, which in calm weather spread out into a fine tree-shape some hundred metres high. The gaseous products reddened litmus paper, and here and there sulphurous anhydride was noticeable; the ground at the top of the cone felt hot, and the temperature at a depth of 50 cm. was about 50° C. Reflected light was not seen at night, and Prof. Semmola hence concludes that the source of activity was at a considerable depth. The general character of the phenomena, and in particular the entire absence of explosions or ashes or projected bodies, points to the activity of Vesuvius being considerable, but the channels of activity being altogether free from any obstructions such as would cause violent action to take place.

MR. RAVENSHAW'S paper on the electrical transmission of power in coal mines, and Mr. Walker's on electrical miners' safety lamps, which appear in the last number of the *Journal* of the Institution of Electrical Engineers, contain, with the joint discussion on the two papers, a great deal of valuable information on this comparatively recent application of electricity. The number of purposes to which electricity can be applied, either to supply an existing want or to replace some less satisfactory method, is continually increasing, and as each new problem is attacked special difficulties present themselves. This is very apparent in this instance, where the dangers peculiar to coal-mining make it essential for the electrician to design special machinery to meet the case. Mr. Walker's paper is very instructive as showing how many difficulties have to be overcome before a lamp can be obtained to compete at all successfully with the existing miner's lamp, although at first sight the electric lamp would seem to be so preeminently the best one to use. Thus, apart from questions of cost and weight, the very safety of the electrical lamp is in itself a drawback, since it does not indicate, as does an oil lamp, the presence of dangerous gases. There can be little doubt, however, that the difficulties have only to be fully realised to be successfully overcome, and in the course of time the use of electricity is likely to become general in coal-mines, for which in essential respects it is so peculiarly suitable.

A FEW more details concerning the adoption of the "Parsons steam turbine" as a source of propulsion in the mercantile marine are now available. The vessel named the *King Edward*, the main dimensions of which have been given in a previous number, has been launched and (says *Engineering* of July 5) has so far quite realised the expectations of her owners. The trials were run on the Firth of Clyde, where, on a mean of runs "over the Skelmorlie mile," the speed of 20·48 knots was obtained. The mean revolutions were registered at 740 per minute, boiler pressure 150 lbs. per sq. inch, a vacuum of 26½ inches, and a stokehole pressure (forced draught) equivalent to one inch of water. Among the advantages of the Parsons steam turbine over the ordinary reciprocating engines the following are mentioned:—(1) The weight of the propelling machinery is 66 tons, being, it is stated, roughly half the weight for an engine (of the same power) employed in a paddle steamer of the same type. (2) On account of the lightness of the turbine machinery, very graceful lines have been introduced into the "model" of the hull, both fore and aft, which otherwise could not have been used. (3) The small amount of room taken up by the turbine machinery. All the machinery is placed below the "main" deck, giving the space above otherwise occupied with engines to additional passenger accommodation. (4) The total absence of noise from the turbines when running. In fact it is stated that it is not possible to tell whether they are running or not; by placing one's hand on them the only slight vibration discernible is right aft, and is due to the propellers. (5) The low centre of gravity of the turbine machinery has given good stability in the *King Edward* without either a "hard bilge or long floor," rendering this class of machinery conducive to high speeds. During the trials Rothesay was "made" as an experiment, and the vessel behaved splendidly, coming to easily and quickly—an important point in passenger excursion traffic, for which the steamer is intended. The *King Edward* is now on her run in Scotland, and is by far the fastest boat of her class.

WE have received from Messrs. Baker and Co., of Newark, U.S.A., an illustrated catalogue of platinum apparatus for use in large and small college chemical operations. The illustrations show a variety of useful contrivances for laboratory purposes, and the catalogue concludes with some valuable observations on the use and care of platinum, on the cleaning of platinum wire, and with some tables which will much assist in calculating the weight, and therefore the price, of platinum apparatus.

THE popular science lectures for young people, which have been given at the Kensington Town Hall during the autumn and winter, will be continued in October next. The aim is to interest juveniles in various aspects of scientific study and encourage them to view natural objects and phenomena in a sympathetic frame of mind. The subjects of lectures arranged for the autumn are secrets in sands, by Mr. C. Carus-Wilson; waves of sound and waves of light, by the Rev. J. O. Bevan; colour and colour photography, by Dr. A. H. Fison; flowers and their insect visitors, by Prof. J. B. Farmer, F.R.S.; and secrets in flint pebbles, by Mr. C. Carus-Wilson.

MR. EDWARD STANFORD has published a South Polar chart which will be of service in following the progress of the expeditions about to sail for Antarctic regions. The chart indicates, by contours and eight shades of blue, the ocean depths, so far as they are known, down to 5000 fathoms and below. Lines are also engraved on the chart to show the approximate limit of the pack ice during the southern summer months, the line of freezing-point in air in January and February, the northern limit of icebergs, and the tracks of the *Challenger*, *Valdivia* and *Belgica* expeditions. It is a little to be regretted that the proposed tracks of the expeditions about to start are not also included, so that the fields of operations of the German and British expeditions could be easily distinguished.

THE paper by Prof. S. P. Langley and Mr. F. W. Very, "On the Cheapest Form of Light," which appeared in the *American Journal of Science* in August, 1890, has been reprinted and published as No. 1258 of the Smithsonian Miscellaneous Collections, with a note pointing out some of the additions to our knowledge of the light from living and mineral sources during the last ten years. It will be remembered that the paper deals with the light of the fire-fly and shows that the insect produces light without heat, so that its efficiency as a light source is far higher than any artificial means of illumination. In connection with this subject, the luminous bacteria cultivated by Mr. J. E. Barnard and Prof. Allan Macfadyen, and shown at the last Royal Society conversazione (see p. 57) are of interest.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. Crandon W. Gill; an Alpine Marmot (*Arctomys marmotta*), European, presented by Mrs. Curtis; a Rough-keeled Snake (*Dasypeltis scabra*), four Rhomb-marked Snakes (*Trimerorhinus rhombeatus*, four Rufescent Snakes (*Leptodira hotamboeia*), three Crossed Snakes (*Psammophis crucifer*), a Coppery Snake (*Prosymna sundevalli*), a Delalande's Lizard (*Nucras delalandii*) from South Africa, presented by Mr. A. W. Guthrie; two Pond Herons (*Ardeola grayi*), a Cattle Egret (*Bubulcus coromandus*), a White-bellied Drongo (*Dicrurus coerulescens*), a Common Hawk Cuckoo (*Hierococcyx varius*), two Baya Weaver-birds (*Ploceus baya*), two Scarlet-backed Flower-peckers (*Dicoeum cruentatum*), two Purple-rumped Sun-birds (*Arachnechthra zeylonica*), a Himalayan Black Bulbul (*Hypsipetes psaroides*) from British India, presented by Mr. E. W. Harper; two European Pond Tortoises (*Emys orbicularis*), European, presented by the Hon. Mrs. Fitzgerald; an Algerian Tortoise (*Testudo ibera*) from North Africa, three South Albemarle Tortoises (*Testudo vicina*), two Central Albemarle Tortoises (*Testudo*, sp. inc.) from the Galapagos, deposited; two Herring Gulls (*Larus argentatus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN AUGUST.

August 2. 2h. Mercury at greatest elongation, 19° 23′ West.
4. 14h. 39m. to 15h. 47m. Moon occults δ Piscium (mag. 4·6).
6. 12h. 16m. Minimum of Algol (β Persei).
9. 9h. 5m. Minimum of Algol (β Persei).
11. Maximum of Perseid meteoric display (radiant 45° + 57°).
13. Saturn. Outer minor axis of outer ring = 17″·94.
15. Venus. Illuminated portion of disc = 0·873, of Mars = 0·915.
15. 7h. 21m. to 10h. 26m. Transit of Jupiter's Sat. III. (Ganymede).
17. 6h. 12m. to 8h. 32m. Transit of Jupiter's Sat. IV. (Callisto).
25. 6h. Saturn in conjunction with the moon. Saturn 3° 42′ S.
28. 12h. 54m. to 13h. 59m. Moon occults c′ Capricorni (mag. 5·2).
29. 12h. 29m. to 13h. 29m. Moon occults κ Aquarii (mag. 5·5).
29. 10h. 47. Minimum of Algol (β Persei).

THE PARIS OBSERVATORY IN 1900.—A Paris correspondent sends us the following note:—The annual report drawn up by M. Maurice Lœwy, director of the Paris Observatory, and adopted by the Observatory Council, has been sent to the National Printing Office for publication. The international mapping of stars not being in operation in three different parts of the southern hemisphere, M. Lœwy, president of the committee, has sent representations to these countries, through diplomatic agencies, with the result that work will soon begin in them. Mr. Thome, director of the National Observatory, Cordoba, has written to M. Lœwy that the Argentine Republic has authorised him to organise an astrophysical service. Mr. Cooke, director of the Perth Observatory in Southern Australia, has been notified by the Colonial Office that a special grant will be at his disposal for the future budget. M. Enrique Legrand, of the Uruguay Republic, has persuaded H.E. M. Cuertas to present a bill for the establishing of an astrophysical service in Montevideo. The work is progressing favourably in all the countries where it has been inaugurated.

M. Lœwy is investigating Prof. Turner's method of determining, from photographs, the positions of the celestial bodies with almost the same exactness as from direct observations in the sky. The report gives for the first time a complete list of the fifty-eight observatories which have taken part in the Eros international observations. According to the last news included in the report, January 6, no single night had passed, since the inauguration of this work, without at least one observatory having made at least one Eros observation. On favourable nights the number of observations exceeded one hundred. MM. Prosper Henry and Boinot took 104 series of photographs of the planet Eros from October 3 to January 6.

Six hundred and seventy stars at a distance of not more than one degree from the path followed by Eros were observed with the meridian circle. For the first time observations of stars were registered on the meridian with a special chronograph invented by the Abbé Verschaffel. Ten sheets, containing 16,500 stars, of the photographic catalogue of the heavens, have been published. Each of these sheets contains a zone of one degree in declination and eight minutes in Right Ascension. Photogravures for the Lunar Atlas have been prepared for publication; they refer to the first and last quarter. On the occasion of the total eclipse of May 28, MM. Hamy and Bigourdan were sent to Spain and were favoured with splendid weather for their observations. M. Bigourdan continues his observations of nebulæ, and the work of his great catalogue is progressing favourably. M. Callandreau observed with the great equatorial of the western tower, and used a wire illuminated only by points in the field of his refractor; he appears to be satisfied with this method, which prevents the eye from being disturbed by too great a quantity of light when observing feeble stars.

M. Gaillot has worked at the theory of Saturn, using Le Verrier's formulæ, and has succeeded in showing that the discrepancies between the results of computation and observation should be attributed to the fact that a sufficient number of terms had not been taken into consideration.

A staff of six women observers, directed by Miss Dorothea Klumpke, has determined the position of 29,627 stars for the International Catalogue. This is the only department of the Observatory where ladies have been admitted. To the meteorological department a new registering barometer has been added; it is a mercury one, and the end of the index runs through 3 mm. for a variation of 1 mm. in mercury. The publication of the old observations from 1837 up to 1886 will be completed this year, and from 1886 on the observations will be published regularly each year. The observations of 1898 were published in 1900, and those of 1899 will appear shortly.

PHOTOGRAPHY BY THE LIGHT OF VENUS.—In the autumn of last year several meagre accounts appeared in various journals announcing that Dr. W. R. Brooks had succeeded in obtaining good photographic records solely by means of light from the planet Venus. In the *Century Magazine* for August (1901), Dr. Brooks has an article describing his experiences, illustrated by reproductions of the photographs obtained at the Smith Observatory. These are chiefly positives taken by placing a landscape or other negative in a printing frame with a sensitive plate and exposing to the light from the planet, care being taken to shield the frame from all extraneous light. The results described were obtained when the planet was a morning star, shortly after September 17, 1900. Gelatine dry plates (speed not stated) were used, the exposures given varying from thirty to forty-five minutes. A print on bromide paper was obtained by exposure on five consecutive clear mornings. The positives are all apparently well exposed, and a portrait is also shown as being produced by the planet's light, but by what procedure is not indicated.

NEW NEBULÆ.—In the *Comptes rendus* (cxxxiii. pp. 206–208), M. Bigourdan continues his catalogue of new nebulæ discovered with the west equatorial of the Paris Observatory. Particulars as to position, notes of special interest and comparisons with other catalogues are given for twenty-three objects observed between 1884 and 1898.

THE CRYSTALLISATION OF SALT SOLUTIONS.

ALTHOUGH the processes of crystallisation have been known to, and made use of by, chemists for ages, yet it is only within the last few years that the phenomenon of crystallisation from solution has been the subject of systematic investigation. The pioneer work in connection with this systematic study on the basis of modern principles has been done, for the most part, by Dutch chemists. The researches of Roozeboom on the equilibrium of systems in contact with water have shown clearly the importance of the phase rule of Willard Gibbs as a guide in the study of the complex phenomena of heterogeneous equilibrium. The study in van 't Hoff's laboratory of the conditions of existence of crystallohydrates and of the phenomena associated with the formation and decomposition of double salts in contact with water has given us invaluable material for a correct understanding of the processes of crystallisation. Not only is the systematic investigation of this phenomenon of importance to the chemist, but the geologist is also dependent on such knowledge for the final explanation of the conditions of formation of the vast oceanic salt deposits.

A knowledge of the composition of the solution in equilibrium with a system of solid substances is obviously an all important factor for the study of the processes of crystallisation, for the separation of any solid substance from the solution requires that the solution shall be saturated with regard to that substance. In what follows it is presumed that the crystallisation takes place so slowly that supersaturation phenomena can be neglected, and the complications resulting from crystallisation of isomorphous mixtures are also left out of account. Furthermore, we suppose that the temperature of the solution remains constant during the crystallisation.

The simplest conditions are then met with in the case of a solution containing a single substance, say a salt, which is not capable of combining with water of crystallisation. If an unsaturated solution of such a salt is evaporated, the commencement of crystallisation is conditioned solely at a given temperature by the attainment of a definite concentration. As evaporation proceeds the salt then separates out continuously, the composition of the solution undergoing no change until the last trace of water has been removed.

If the dissolved salt forms crystallohydrates, *i.e.* salts with water of crystallisation, then the products of isothermal evaporation are dependent upon the temperature, a less hydrated form separating as the temperature is higher. Thus solutions of manganese chloride yield the tetrahydrate if the temperature does not exceed 58° C., whereas at higher temperatures the dihydrate crystallises out. It is well known that salts containing water of crystallisation undergo at a definite temperature a change in which the whole or part of the water of crystallisation is split off. Glauber's salt loses its ten molecules of water at 32·4° C.; ordinary zinc sulphate containing seven molecules of water yields the hexahydrate at 39° C., and this again, at a higher temperature, yields a lower hydrate. These temperatures are known as the transition temperatures of the salt hydrates, and have a far-reaching analogy with the melting points of solid substances.

The limiting temperatures corresponding to the crystallisation of a definite hydrate from the salt solution are determined by the transition temperatures of the solid hydrates.

If supersaturation phenomena intervene we may observe the separation of hydrates from solution at temperatures below the normal limiting temperature. It is, however, only under this condition that crystallisation of such unstable hydrates takes place, for at a given temperature the unstable hydrates are more soluble than the stable hydrate. If the solution from which an unstable hydrate has begun to crystallise out be impregnated with the hydrate of smaller solubility, the unstable hydrate will redissolve and crystallisation of the normal hydrate ensues

If a solution contains two dissolved salts having a common ion, the phenomena of crystallisation are about as simple as in the case of a solution containing a single salt. Let us suppose, in the first instance, that these salts do not unite to form a double salt, and that they do not form crystallohydrates. Such a solution is one containing the chlorides of sodium and potassium, and in this case a knowledge of the composition of the three solutions, saturated respectively with regard to each single salt and with regard to both simultaneously, enables us to predict what will take place on isothermal evaporation. A graphic representation of the solubility data facilitates the tracing of the crystallisation process very considerably, and the composition of the various solutions is conveniently expressed by the number of molecules of dissolved salt per 1000 molecules of water. Fig. 1 contains the data for the system consisting of water, potassium chloride and sodium chloride at 25° C., A representing the saturated solution of sodium chloride, B that of potassium chloride, and C the solution saturated with regard to both.

Along the curve A C we have solutions saturated with regard to sodium chloride in which the potassium chloride concentration gradually increases. Similarly, the points along the curve B C represent solutions containing increasing quantities of sodium chloride, all of which are saturated with reference to potassium chloride.

All points within the figure O A C B represent unsaturated solutions, the quantities of the dissolved salts being given by the lengths of the projections on the axes. If a solution corresponding to the point *c* is slowly evaporated at 25° C., the change in the composition of the solution will be represented by the continuation of the line O *c* (O corresponding to pure water). At the point *d*, where this line meets the curve B C, the solution becomes saturated with potassium chloride and the latter crystallises from solution. By the continued separation of potassium chloride the relative proportion of sodium chloride in the solution increases, and the composition of the solution is represented successively by points on *d* C. At C sodium chloride begins to crystallise and the two chlorides are then deposited in the proportions determined by the position of C on the diagram until the evaporation is complete. The arrows indicate the course of crystallisation for any given solution.

The phenomena of crystallisation may be somewhat more complicated if the two salts in solution are capable of double salt formation. Whether the double salt crystallises out on evaporation depends essentially upon the temperature. For example, the evaporation of a solution containing the chlorides of calcium and magnesium yields a mixture of the simple salts below 22° C., whereas at a higher temperature the double salt, tachhydrite, $CaCl_2.2MgCl_2.12H_2O$, accompanied in general by one of the simple salts, crystallises out.

Let us consider the crystallisation of a solution containing the sulphates of magnesium and potassium at a temperature of 25° C., this lying between the limiting (transition) temperatures at which the double salt, schönite, $K_2SO_4.MgSO_4.6H_2O$, is formed and decomposed.

The solubility data which furnish us with fixed points by means of which the course of crystallisation is determined are in this case four, viz., the saturated solutions of (1) $MgSO_4.7H_2O$, (2) K_2SO_4, (3) schönite and $MgSO_4.7H_2O$, (4) schönite and K_2SO_4.

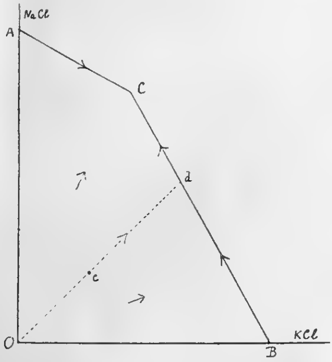


FIG. 1.

In Fig. 2, where potassium sulphate is measured off on the abscissa and magnesium sulphate on the ordinate, these solutions are represented respectively by the points A, B, C and D. The connecting curves have the same significance as in Fig. 1.

Suppose we slowly evaporate at 25° C. a solution the composition of which is given by the point *a*, which lies on the line bisecting the angle between the axes; this solution obviously contains equivalent quantities of potassium and magnesium sulphates. The index point representing successive conditions of the solution advances along the continuation of O *a* until the point *b* is reached, when the solution becomes saturated with potassium sulphate. As evaporation continues and crystallisation of potassium sulphate takes place we advance along *b* D until at the latter point the solution becomes saturated with regard to schönite. On further loss of water schönite crystallises out, and since the molecular concentration of magnesium sulphate in the solution is greater than that of potassium sulphate, the continued separation of the double salt increases the molecular ratio $MgSO_4 : K_2SO_4$ in the solution, corresponding to a movement of the index point along D C, the curve of saturation of the double salt. If the solution were agitated so as to bring the separated K_2SO_4 into intimate contact, some of the latter would again pass into the solution and reappear as schönite. At the point C the solution becomes saturated with regard to $MgSO_4.7H_2O$, and Epsom salts and schönite now crystallise out together until the solution completely disappears. The point C represents the crystallisation end point of all solutions containing magnesium and potassium sulphates, the final separation from all such solutions being a mixture of schönite and Epsom salts. The arrows in the figure show the course of the crystallisation for any solution.

If we now suppose that one of the two salts is capable of dehydrating the other when the solution becomes concentrated, the products of crystallisation which are first separated may undergo a series of successive transformations. If the two salts in solution do not unite to form a double salt, as in the case of magnesium sulphate and magnesium chloride, the

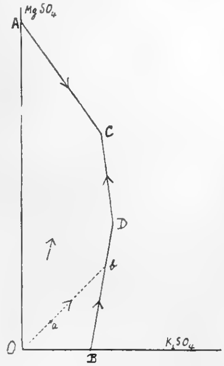


FIG. 2.

phenomenon to be discussed appears in its simplest form. It may be pointed out that the temperature at which any hydrate is transformed into a lower hydrate is lowered if foreign substances are added to the aqueous solution with which the two hydrates are in equilibrium at the transition temperature, just in the same manner as the melting point of a pure substance is lowered by foreign admixtures. Consequently we may expect, at one and the same temperature, higher or lower hydrates to crystallise out from a solution according as the mother liquor contains small or large quantities of other soluble substances.

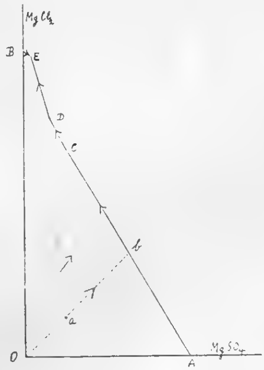


FIG. 3.

The application of these known facts to the crystallisation of a solution containing the sulphate and chloride of magnesium at 25° C. enables us to explain completely the successive changes observed.

Representing, as before, the composition of the saturated solutions of these salts on a system of coordinates, Fig. 3 is obtained. A and B represent the saturated solutions of

$MgSO_4.7H_2O$ and $MgCl_2.6H_2O$ respectively; the point E, which corresponds to the point C in Fig. 1, represents a solution saturated simultaneously with regard to $MgCl_2.6H_2O$ and the hydrate $4MgSO_4.5H_2O$. The broken curve joining A and E has reference to solutions which are saturated with one or other of the hydrates of magnesium sulphate, but not with magnesium chloride.

If a solution containing equivalent quantities of these two salts and represented by the point *a* is evaporated at 25° C., then, as in the cases already considered, separation of salt, viz. $MgSO_4.7H_2O$, will take place when the index point moving along O *a* reaches the curve C A.

As the concentration of the magnesium chloride in the solution increases, we move along the curve A C until at the point C this concentration has attained such a magnitude that the transition temperature $MgSO_4.7H_2O \rightarrow MgSO_4.6H_2O$ has been lowered from 47° C. to 25° C. The separated $MgSO_4.7H_2O$ in contact with the solution is now transformed into $MgSO_4.6H_2O$, and by further evaporation the index point moves along the curve C D, a further quantity of $MgSO_4.6H_2O$ crystallising out. At D the system undergoes a similar change to that which took place at C; $MgSO_4.5H_2O$ crystallises out and the $MgSO_4.6H_2O$ now disappears. Further changes of like character (not indicated in the diagram) are experienced as the magnesium chloride concentration increases, whereby $MgSO_4.4H_2O$ and $MgSO_4.2H_2O$ appear successively. At the point E the hydrate $4MgSO_4.5H_2O$ displaces the dihydrate and the solution then becomes saturated also with regard to $MgCl_2.6H_2O$. These two salts now crystallise out together until the solution completely disappears; the point E represents the crystallisation end point of all solutions containing the sulphate and chloride of magnesium. As before, the arrows indicate the course of the crystallisation for any given solution.

The above crystallisation phenomena may be regarded as typical for solutions containing two salts with a common ion.

The phenomena are much more complex if the solution contains four different ions, as in a solution of the chlorides and sulphates of magnesium and potassium. The four simple salts and their various hydrates, as well as several double salts, may in general crystallise out from such a solution. The course of crystallisation of the solution referred to has been carefully worked out by van 't Hoff, Meyerhoffer and their pupils. The phase rule serves as a safe and sure guiding principle; solubility determinations and measurements of the vapour pressures of solutions supply the data which, when graphically represented in a suitable manner, enable us to follow the various phases of the crystallisation process with almost the same ease as in the simpler cases. The diagram representing the various saturated solutions formed by the system composed of water and the sulphates and chlorides of magnesium and potassium has been tested by a qualitative and quantitative study of the products of isothermal evaporation, and the course of crystallisation is found to agree perfectly with that indicated by the motion of the index point on the diagram. In this short article it is not possible to treat of this more complicated case in detail; suffice it to say that all solutions containing the above-mentioned salts deposit in the last stage of crystallisation a mixture of carnallite, $MgCl_2.6H_2O$ and $4MgSO_4.5H_2O$.

The above sketch gives some idea of the preliminary work in connection with the problem of explaining, on a physico-chemical basis, the formation of the oceanic salt deposits. It indicates the initial stages of the synthetic method pursued by van 't Hoff in his treatment of this highly interesting problem.

H. M. DAWSON.

BOOMERANGS.[1]

BOOMERANGS may be studied for their anthropological interest as examples of primitive art,[2] or for the manner in which they illustrate dynamical principles.[3] But there is extraordinary fascination in making and throwing them, and in watching the remarkable and always graceful curves described in their flight; accordingly, my chief object in the following paper has been to diminish the practical difficulties of the subject by giving some of the results of ten years' experimental acquaintance with it.

The Australian weapons vary enormously in shape and size, while the skill of the natives in throwing them is great in some districts and very small in others. The marvellous flights that were described by former travellers are but rarely seen to-day, and although it is undeniable that many a native can make a boomerang go 80 metres away before returning to his feet, I know of only one trustworthy account of a much more sensational throw.[1] In this the boomerang described five circles in the air, travelling to a distance of about 90 metres from the thrower and rising to a height of 45 metres.

For present purposes it will be convenient to consider two types of implements. The first (Fig. 1) is about 80 cm. in length, measured along the curve, is bent (at B) almost to a right angle, and has the cross section shown in Fig. 2. It is about

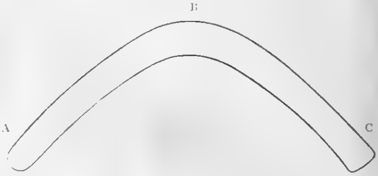


FIG. 2.

FIG. 1.

6·5 cm. wide and 1 cm. thick in the centre at B, and the dimensions of the cross section diminish slightly towards the ends A and C; the weight is about 230 grams. The arms are twisted from the plane ABC after the manner of the sails of a windmill, being rotated through 2° or 3° in the direction of a right-handed screw about the lines BA, BC as axes. This deviation from the plane is subsequently referred to as the "twist," and the peculiarity that, as seen in the cross section of Fig. 2, one face is more rounded than the other, is called the "rounding."

Boomerangs of the second type (Fig. 3) are about 70 cm. long and 7 cm. wide, and have a cross section similar to that of Fig. 2. The "twist" is in the opposite direction, involving a left-handed rotation of about 3°; the axes of rotation are now DE, FE instead of ED, EF.

Returning Flights.—An implement of the first type is held with the more rounded side to the left and the concave edge

FIG. 3.

forwards. It is thrown, with plane vertical, in a horizontal direction and as much rotation as possible is given to it. The plane of rotation does not remain parallel to its original direction, but has an angular velocity (1) about the direction of translation, and (2) about a line in its plane perpendicular to this.

The effect of (2) is that the path curls to the left; while owing to (1) the plane of rotation inclines over to the right (*i.e.* rotates in the direction of the hands of a clock facing the thrower) and its inclination to the vertical becomes comparable with 30° in two seconds. The angular velocity (2) will now imply that the path bends upwards as well as horizontally round to the left.

When the boomerang has described a nearly complete circle its pace has diminished, and it falls to the ground near the thrower. (See Figs. 4, 5, in which projections on a horizontal and on a vertical plane are given; the direction of the axis of rotation is indicated by giving the projections of a line of

[1] This paper is here published by permission of the editors of the *Physikalische Zeitschrift*, for which it was originally written. A German translation has appeared in that journal, and from its publishers the accompanying illustrations have been obtained.

[2] "The Native Tribes of Central Australia," by B. Spencer and F. J. Gillen (1899), Ch. xix.

[3] E. O. Erdmann, *Ann. d. Phys. u. Chemie.*, vol. cxxxvii. p. 1 (1869); E. Gerlach, *Zeitschr. d. D. Vereins z. Förd. d. Luftschiffahrt*, Heft 3 (1886); G. T. Walker, London *Phil. Trans.*, vol. cxc. p. 23 (1897).

[1] Mr. A. W. Howitt, NATURE, July 20, 1876.

constant length measured along it. The scale of these diagrams is about 1:1000).

The angular velocity (1) is increased by an increase of twist and by an increase of rounding; it also increases when cos θ increases, where θ is the inclination of the plane of rotation to the horizontal. The curling to the left (2) is increased by an increase of twist, or of cos θ, and, in general, by an increase of rounding.

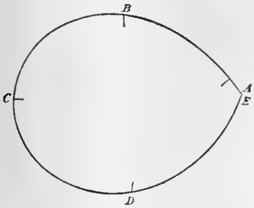


FIG. 4.—Plan.

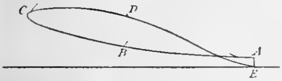


FIG. 5.—Elevation through CA.

If it be desired that the boomerang should describe a second circle in front of the thrower (Figs. 6, 7), it must be thrown much harder, so that when one circle has been described it may still have sufficient forward velocity. When the projectile has described the first circle and is over the thrower's head, the axis of rotation must point in an upward direction in front of him; if it pointed behind him the subsequent path would be behind his back, and a figure of eight (Figs. 8, 9) would become possible. For a path with a second loop in front of the thrower

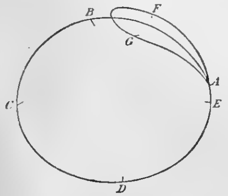


FIG. 6.—Plan.

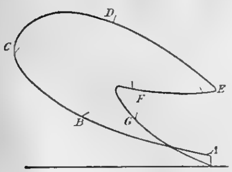


FIG. 7.—Elevation through CE.

he should accordingly choose a boomerang with much twist and much rounding, and throw it with his body leaning over to the left, so that the angle θ between the axis of rotation and the vertical may be slightly in excess of a right angle. The increased twist will mean that the first circle has a smaller circumference and that there will be more pace left after it has been described; and the increased rounding will keep the plane of rotation from becoming horizontal too soon.

For a figure of eight we should require less rounding, or we might give more spin in throwing, and aim a little uphill with θ rather less than a right angle. There are so many elements capable of variation that nothing but experience can teach how to get the best results with any particular boomerang.

The most complex path that the author has succeeded in

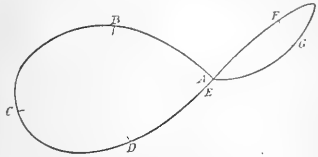


FIG. 8.—Plan.

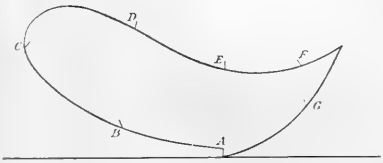


FIG. 9.—Elevation through CAG.

effecting is that of Figs. 10 and 11. But it is certain that these fall far short of what is done by skilful natives of Australia.

If the angle between the arms is increased and the twist and rounding unaltered, the angular velocity (1) is increased, and it becomes easier to make a second loop behind than in front. If the angle exceeds 150°, the angular velocity of the first kind is so large that it is very hard to get a return at all.

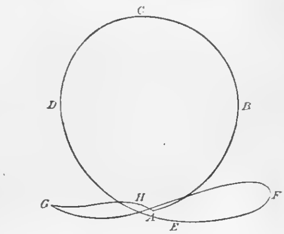


FIG. 10.—Plan.

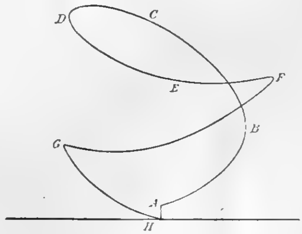


FIG. 11.—Elevation through GF.

When the twist is left-handed and the angle large we have a specimen of the second type (Fig. 3), and it must be thrown with the more rounded side uppermost and the plane of rotation inclined at between 30° and 60° to the horizontal (*i.e.* $30° < \theta < 60°$); the angle of projection (*i.e.* inclination to the horizon of the initial velocity of translation) must be comparable with 45°.

The uphill path is nearly straight until the forward velocity becomes small; the projectile then returns along a track close to that of the ascent (Figs. 12 and 13).

Non-returning flights.—A good boomerang of the second type will travel an immense distance in a nearly straight line if properly thrown. The motion should resemble that of an aëroplane or flying machine; the plane of rotation must remain nearly horizontal though slightly uphill, and the trajectory must be flat. There will thus be an upward pressure of air on the under surface of the implement, and the force of gravity will be counteracted as long as there is sufficient forward velocity. The boomerang is thrown very slightly uphill, the angle of projection not being greater than 12°; the rounded side is uppermost and θ is initially 30°. The plane of rotation soon appears to the thrower to become approximately horizontal, and it remains so during the flight; the projectile rises to a height of about 12m. from the ground and travels in a nearly straight path until its forward velocity is almost exhausted; it then strikes the earth at a distance of about 130 metres from the thrower.

It will be seen that the angular velocity (1) is at first small and positive, and that it subsequently disappears; the angular velocity (2) is small throughout. These results are due to the left-handed twist and the rounding.

Considerable accuracy both in making and in throwing is necessary if the best results are to be obtained. If the plane of rotation slopes downward to one side, the boomerang will slide down in the inclined plane of rotation; thus the path will be bent and materially shortened. The correct relation has to be found between the twist, the rounding, the angle between the arms of the boomerang, the density of its material, and the amounts and directions of its initial linear and angular velocities. An illustration of this is afforded by the first specimen of this type that I have made; it travels further against the wind than with it. In the former case the boomerang keeps quite low, scarcely rising higher than 6 metres, and, being retarded very little by frictional resistance, travels about 125 metres; in the latter case the body spends its energy in running uphill to a height of about 15 metres, and falls to the ground at a distance of about 90 metres.

FIG. 12.—Plan.

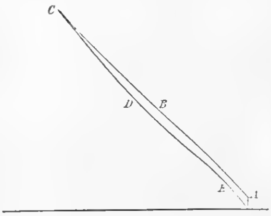


FIG. 13.—Elevation through AC.

It is rather difficult to give sufficient spin to keep the motion stable through a long flight, and I have found it advantageous to wind round the wood about 60 grammes weight of copper wire in three equal portions, of which one is in the middle and one near each end. This materially increases the moment of inertia about the centre of gravity without interfering seriously with other details. I have thrown a loaded boomerang of this type 167 metres, and my range with a spherical ball of half the weight is only 63 metres.

Mode of manufacture.—A block of straight-grained ash about 90 cm. long, 7 cm. (or 7·5 cm.) thick, and of width not less than 7 cm. is taken. The block is soaked in steam, bent to the requisite shape and held in this shape until cool and dry. It is then sawn into strips 1·3 cm. thick. After sufficient time has lapsed for the wood to be seasoned, each strip is trimmed into a boomerang, the most useful tool in general being a spokeshave. It is very important that the outer edge, at any rate in the neighbourhood of the bend, should follow the grain of the wood. When the projectile falls hard upon one end the stress near the centre is very severe, and any point at which the direction of the grain meets the convex edge obliquely is likely to develop a split and ultimately a breakage.

It is better to cut the material to its final twisted shape rather than to impart the twist by another steaming and bending. Considerable care is required in the process, for the removal of a layer of wood a millimetre thick in such a way as to increase or diminish the twist will cause a marked difference in the flight. It will be found to facilitate throwing to cut that end of the boomerang which is held in the hand to the somewhat square form shown at the right hand of Figs. 1 and 3.

There is some difficulty in avoiding warping, for boomerangs are less likely to get broken if thrown when the ground is damp and soft, and under these circumstances the moisture is likely to be absorbed by the wood. It is of great advantage, therefore, to make the surface of the implements very smooth with fine glass-paper and to saturate them with linseed oil. The additional density thereby produced is also of service in that it diminishes the effect of the frictional resistance of the air.

I have used artificially bent oak as a material, but have not found it as heavy or as strong as ash. Oak branches that are naturally bent are not hard to procure, but boomerangs made from them are liable to break at places where there are knots or irregularities in the grain of the wood.

Evolution.—Boomerangs of every variety of shape are still to be found in Australia, and it appears impossible to get direct historical evidence as to the nature of the successive stages of development. But if speculation be allowed, the following series may be suggested.

First we should have a clumsy kind of wooden sword, curved, but without rounding or twist, and with one end roughened to form a handle; when the intended victim was out of reach it would be natural to throw the weapon, and at short ranges it would be extremely effective. Bad workmanship would involve the frequent production of implements of which one side was more rounded than the other, and it would soon be found that these missiles, when thrown with the rounded side uppermost, travelled much further and straighter than the former.

Boomerangs of this character vary in length from 50 to 110 cm., and in weight from 200 grammes to 1250. They are, for the most part, twisted in a manner that seems quite fortuitous, and form the enormous majority of the present native implements. Light specimens with a slight left-handed twist may have a fairly straight trajectory of 100 metres, and may return if aimed much uphill, especially when thrown against a wind. Those which are bent through a large enough angle and happen to be twisted (either by carelessness in manufacture or by subsequent warping [1]) after the manner of a right-handed screw are returning boomerangs of the first type. In many of these the twist is so large as to be conspicuous, and when once the connection between the form and the return flight has been noticed, the process of development is complete.

GILBERT T. WALKER.

THE INTERNATIONAL SEISMOLOGICAL CONFERENCE AT STRASSBURG.

IN 1895 the late Dr. Rebeur-Paschwitz proposed, with the approval of Prof. Milne and other seismologists, to form an international seismological union. Although, unfortunately, he did not live to carry the project into execution, the microseismic survey of the world has since then been actively pushed on by Prof. Milne, the observatories using the Milne horizontal pendulums now numbering about forty. Meanwhile, the project of Rebeur-Paschwitz was taken up by Prof. Gerland, and, thanks to his active exertions, the first international seismological conference was finally held at Strassburg on April 11–13. The total number of the members who attended the conference was thirty-five, as follows:—*Austria-Hungary* (Prof. Belar, Prof. Exner, Prof. von Kövesligethy, Hofrath Konkoly, Prof. Láska, Prof. Schafarzik); *Belgium* (Prof. Langrange); *Denmark* (Lieutenant-Colonel Harboe); *Germany* (Dr. Ebell, Dr. Ehrismann, Prof. Futterer, Prof. Gerland, Prof. Günther, Dr. Hecker, Prof. Helmert, Herr Jaehnike, Prof. Kobold, Geheimrath Lewald, Prof. Leutz, Prof. Rudolph, Dr. Polis, Prof. Schmidt, Dr. Schütt, Prof. Straubel, Dr. Tetens, Prof. Wagner, Prof. Weigand, Prof. Wiechert); *Italy* (Dr. Oddone); *Japan*

[1] This may be illustrated by the fact that when the author first made boomerangs he was only aware of the need for rounding; but the first two specimens that he constructed happened to have right-handed twist and returned admirably.

(Dr. Omori); *Russia* (General Pomerantzeff, Prof. Lewitzky, Dr. Wosnesjenskij); *Switzerland* (Prof. Forel, Prof. Riggenbach). Among these thirty-five members there were sixteen official delegates for the different States, as follows:—*Austria-Hungary*, 1; *Belgium*, 1; *Germany*, 9; *Japan*, 1; *Russia*, 2; *Switzerland*, 2.

The principal object of the conference was the establishment of an international seismological union. After some discussion the *projet* of statutes of an "International Seismological Association," formed principally in imitation of the statutes of the International Catalogue Association and of the International Geodetic Association, was unanimously accepted by the conference, the chief points being as follows:—

§ 1. The object of the Association is the advancement of knowledge of all the seismological problems, which can be solved only by the cooperation of numerous seismological observatories all over the world. As the principal means of attaining this object are proposed:—(1) seismological observations according to fixed plans; (2) experiments on certain important seismological questions; (3) establishment and support of seismological stations in certain countries which need assistance from the Association; (4) organisation of a central bureau for collection and discussion of the reports from various countries.

§ 3. The parts of the Association are:—(1) general meeting; (2) permanent commission; (3) central bureau.

§ 5. The permanent commission consists of the director of the central bureau and of one member from each of the States which compose the Association. . . .

§ 8. Each State must duly communicate to the central bureau, through its local central bureau, the results of seismic observations and experiments.

§ 9. Each State must contribute to the central bureau a certain yearly sum of money, to be fixed in proportion to the number of the inhabitants. The sum thus contributed by the different States is to be appropriated to the following purposes:—(1) publications and administration; (2) remuneration to the general secretary; (3) support of those who work in special important seismological investigations; (4) support of those seismological observatories which are established by the Association. The distribution of the sum into these various items is to be decided by the permanent commission.

As to the seismological observations, experiments and publications in the different States, the latter have a perfect freedom. The choice of the instruments is also left free to each State. The statutes of the Association having been thus adopted by the conference, the further steps for the formation of the Association are now to be taken by the Imperial German Government through diplomatic channels.

As there is still one year or so before the Association can be actually formed, it was proposed by Prof. Helmert to establish a provisionary central bureau and let the latter begin at once the function for the international seismological investigation, under the cooperation of all the members present, who approved the proposal and promised to send in publications and reports. Prof. Forel proposed, in the name of all the non-German members to select the Strassburg Seismological Observatory as the provisionary central bureau, under the direction of Prof. Gerland. This proposal was accepted, the Association being thus provisionally formed. Besides the establishment of the statutes, there were given by Prof. Helmert and others a series of valuable reports and lectures on observational as well as theoretical seismology.

The first international seismological conference proved to be a very satisfactory one. The full minutes of the transactions are expected to be published shortly. F. OMORI.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. R. T. HEWLETT, of the Jenner Institute of Preventive Medicine, has been appointed professor of general pathology and bacteriology at King's College, London.

THE following candidates have passed the D.Sc. examination of the University of London:—Mathematics and Physics, J. Buchanan; Experimental Physics, C. V. Drysdale, W. H. Eccles, P. E. Shaw; Chemistry, T. J. Baker, T. A. Henry, W. H. Hurtley, G. D. Lander, H. R. Le Sueur, S. Smiles.

THE following regulation from the new Calendar of the Imperial University at Kyoto show that the Japanese are encouraging scientific research among University students:—"In June and December every year each student shall report to the director of the College, through his professor, the state and progress of research which he has made in his study of special subject; and the director shall submit such report to the Faculty meeting for examination. When a student has completed the work of research at the University Hall, he shall prepare a record of his career at the University and present it to the president of the University, through his professor." Progress is bound to be made where education is carried on in this spirit.

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, July.—Surfaces whose first and second fundamental forms are the second and first respectively of another surface, by Dr. Eisenhart, was read at the February meeting. The results arrived at are—the ruled surfaces, defined by the equations

$$y + \mu x = \sqrt{1+\mu^2} + C_1\mu + C_1$$
$$z - ix\sqrt{1+\mu^2} = \mu + C_1\sqrt{1+\mu^2} + C_3,$$

are the only surfaces whose first and second fundamental forms can be taken for the second and first fundamental forms of a surface. Further, the second surface is only the first to a translation *près*. And of these surfaces the only real one is the sphere of radius unity—the C's, as usual, are arbitrary constants. References are given to work by Bianchi, Casorati, Monge and Forsyth.—On the groups generated by two operators, by Dr. G. A. Miller, was read at the April meeting. This short note, which gives several references, discusses the theorem, "every group that is generated by two operators of order two is a dihedral rotation group, and every dihedral rotation group is generated by two operators of order two."—Mr. G. Peirce gives a curious approximate construction for π, read at the same meeting. This is as neat a construction as we can remember.—Non-Euclidean geometry is a short notice, by J. L. Coolidge, of a work with this title by Dr. H. P. Manning.—J. K. Whittemore gives an extended abstract of "Vorlesungen über Differential geometrie" (pp. xvi + 659), a translation of Bianchi's work by M. Lukat.—Notes, new publications, tenth annual list of papers (read before the Society, with references to their places of publication), and a full index close the number and the volume.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 20.—"Further Observations on Nova Persei. No. 3." By Sir Norman Lockyer, K.C.B., F.R.S.

In a former paper an account was given of the observations of the Nova, made at Kensington between March 5 and March 25 inclusive. The observations are now brought up to midnight of May 7. Between March 25 and the latter date, estimates of the magnitude of the Nova have been made on thirty-three evenings, visual observations of the spectrum on twenty-five evenings, and photographs of the spectrum on six evenings.

The 10-inch refractor with a McClean spectroscope has generally been used for eye observations. The 6-inch prismatic camera has not been available for photographing the spectrum owing to the faintness of the Nova, but photographs have been secured by Dr. Lockyer with the 30-inch reflector on the nights of March 27, April 1 and 12, and by Mr. Fowler on March 26 and April 4. With the 9-inch prismatic reflector the spectrum was photographed by Mr. Hodgson on March 30, April 1 and 4.

Change of Brightness.—Since March 25 the magnitude of the Nova has been undergoing further periodic variations, and although observations have not been made on every night since that date, owing to unfavourable weather, yet sufficient data have been gathered to enable a general idea of the light changes to be obtained, and the few gaps can be filled up later by other observers who experienced clearer skies on these occasions.

A table is given containing observations for magnitude made from March 26 to May 5 inclusive.

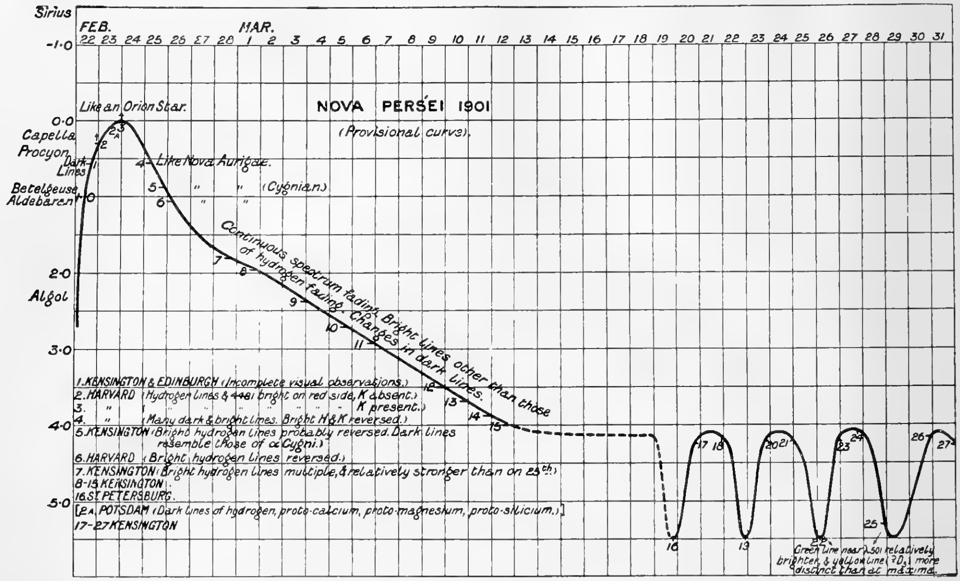
The observations show that the length of the period of variability, reckoning from maximum to maximum, began after March 27 to increase from *three* days to *four* days.

The two following maxima, after that of April 8, occurred on the 13th and 18th, so that the period became still more lengthened, namely to about *five* days. Further observations up to May 5 seem to indicate that the five-day period is shortening.

Another interesting observed fact was that the light of the Nova at the minimum on the 25th was more intense than at the preceding minimum on the 21st, the estimated difference of magnitude at these times being about 4-tenths of a magnitude.

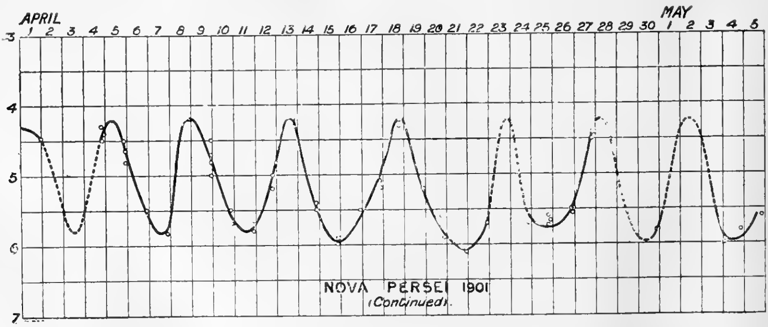
The curve is drawn to satisfy as far as possible all the observations made at Kensington. The dotted portions represent the possible light-curve for those times when no estimates for magnitude could be secured.

In the plates the abscissæ represent the time element and the ordinates that of magnitude.



Colour.—In the first part of the period covered by the later observations, the colour of the Nova has been generally described as yellowish-red, red with a yellow tinge and yellow with a reddish tinge. Since April 25 the colour has been perhaps more red than formerly and sometimes noted as very red.

It is interesting to remark that the colour varies periodically with the change in magnitude. At maximum it is of a distinct yellowish-red hue, but at or near minimum the yellowish tinge disappears and the Nova appears very red.



Unfortunately the increasing twilight and the unfavourable position of the Nova make it very difficult now to determine the magnitudes correctly.

The two plates accompanying this paper illustrate graphically the various fluctuations of the light of the Nova from February 22, when it had not quite attained its maximum brilliancy, to May 5.

The Visual Spectrum.—In the continued observations the C and F lines of hydrogen have always been recorded as "conspicuous," other prominent lines being near λ 447, λ 465 and λ 501 (the last named being sometimes as bright as F or even brighter), and a line in the yellow which recent measures show to be D_3.

The strong lines in the green at λλ 4924, 5019, 5169 and 5317, which occurred in the earlier photographs and which were ascribed to iron, are either absent from the later photographs or appear only as very weak lines.

It has been noted that the lines 447, 501 and D_3 appear to vary with the magnitude of the star, becoming relatively more prominent towards a minimum.

The continuous spectrum has been described throughout as "weak" or "very weak."

On the evening of April 25 Messrs. Fowler and Butler made comparisons of the Nova spectrum with the spectra of hydrogen, helium, and that furnished by an air spark between poles of iron and zinc. For this purpose a Hilger two-prism star spectroscope was used with the 10-inch refractor. The hydrogen line F and the helium line D_3 were found to be sensibly coincident with Nova lines. The middle of the strong green line, previously mentioned as λ 501, practically coincided with the nitrogen line 5005·7, and therefore there is little doubt that it is identical with the chief nebular line λ 5007·6. This line was also compared with the asterium line at λ 5015·7, but was found to be decidedly non-coincident with it, though of sufficient breadth to nearly reach it.

Photographic Spectrum.—In so far as the number and positions of the lines are concerned, the few photographs available for discussion were obtained in the early part of the period dealt with in the present paper (March 26 to May 7), and show a

LIGHT CURVE OF H_β
(30-inch reflector).

spectrum very similar to that of March 25, which was described in detail in the last paper. The chief lines shown in the photographs are Hβ, Hγ, Hδ, Hε and Hζ, together with 4471 and 4650.

Characteristics of Hβ.—In continuation of the series of light curves of Hβ reproduced in the last paper, I give those plotted by Mr. Baxandall from the later photographs.

It will be seen that the line Hβ still shows two maxima of intensity. As recorded in the previous paper, the less refrangible component gave indications of becoming brighter than the more refrangible member. These further photographs indicate that by April 4 the less refrangible had become twice as intense.

"Total Eclipse of the Sun, May 28, 1900.—Account of the Observations made by the Solar Physics Observatory Eclipse Expedition and the Officers and Men of H.M.S. *Theseus* at Santa Pola, Spain." By Sir Norman Lockyer, K.C.B., F.R.S.

The Report gives details as to the erection of coronagraphs, prismatic cameras and other instruments, and of the results obtained by their use during the eclipse, which was observed under very favourable circumstances. Some of the more obvious results have already been stated in a Preliminary Report (*Roy. Soc. Proc.*, vol. lxvii. p. 341), and the following remarks may now be added.

A comparison of the photographs taken with the coronagraph of 16 feet focus with those taken about two hours earlier in America indicates that while some of the prominences changed greatly in appearance in the interval, no changes were detected in the details of the corona.

The spectrum of the chromosphere, as photographed with the prismatic cameras, so greatly resembles that of 1898 that it has not been considered necessary to make a complete reduction of wave-lengths. The prominences visible during totality had comparatively simple spectra, the greatest number of lines recorded being thirty-six.

The heights above the photosphere to which many of the vapours can be traced in the photographs are tabulated and compared with the results obtained in 1898; the two sets of figures are sufficiently accordant, except in the case of the shorter arcs, the value 475 miles derived for the lowest measurable vapours in 1898 being represented in 1900 by two strata, one reaching to 700 miles and the other to 270 miles above the photosphere.

The bright-line spectrum of the corona was decidedly less bright than in 1898, and a much smaller number of rings is seen in the photographs. The three brightest rings are at wavelengths 5303·7, 4231·3 and 3987·0, and it may be noted that these were also the brightest in the eclipses of 1893, 1896 and 1898. The conclusion that the different rings do not originate in the same gas, arrived at from a discussion of the photographs of 1898, has been confirmed.

A drawing is given to illustrate the fact that while the details of the green coronal ring are seen in the inner corona, they have no apparent relation to the positions of the great streamers or prominences. For an investigation of this nature the photographs taken with the prismatic camera of 20 feet focal length are specially valuable.

"On the Mathematical Theory of Errors of Judgment, with Special Reference to the Personal Equation." By Karl Pearson, F.R.S.

EDINBURGH.

Royal Society, July 1.—Prof. Chrystal in the chair.—Dr. Thomas Muir communicated a note on a proposition given by Jacobi in his *De Determinantibus functionalibus*, pointing out that the theorem in question was not so general as might at first reading seem to be implied.—Dr. R. H. Traquair read a paper on the distribution of fossil fishes in the Carboniferous rocks of the Edinburgh district. From a complete classification of the known forms, eighty-four in all, it was shown that the same genera and species were found in all the estuarine deposits, even though these were separated by marine limestones which contained a totally distinct set of fossil remains. There was no evidence of life zones. The forms were persistent and no evolutionary change could be detected. After the Millstone Grit there was no further appearance of the characteristic estuarine forms.—Dr. J. Beard, in a paper on the determination of sex in animal development, argued that the sex of the animal into which a given ovum developed was determined from the very beginning before the act of fertilisation. The argument was supported by an array of facts in embryology, such as the two kinds of oocytes which had been observed in certain animals.

July 15.—The Rev. Prof. Flint in the chair.—The chairman made a suitable reference to the sad loss which the Society and the wider world of science had suffered in the recent death of Prof. Tait, who had been their general secretary for more than twenty years.—The following prizes were then presented: the Gunning Victoria Jubilee prize to Dr. T. D. Anderson for his discoveries of new and variable stars; the Keith prize to Dr. James Burgess, C.I.E., for his paper on the definite integral $\sqrt{\frac{2}{\pi}}\int_0^t \epsilon^{-t^2}dt$ with extended tables of values; and the Makdougall-Brisbane prize to Dr. R. H. Traquair for his report on fossil fishes collected by the Geological Survey in the Upper Silurian rocks of Scotland.—Mr. C. Tweedie communicated a paper on the general form of the involutive one-one quadric transformation in a plane.—In a supplementary report on the fossil fishes from the Silurian rocks of the south of Scotland, Dr. Traquair announced some new anatomical features which he had discovered in these fish remains. Thus in some specimens of Cœlolepidæ, two dark spots were found probably representing the position of the eyes; and in one specimen of *Lasanius problematicus*, vertical angulated lines were seen which might very reasonably be regarded as the remains of body muscle. Nearly perfect specimens of *Ateleaspis tesselata* show this remarkable genus to have close affinity to *Cephalaspis*, having two orbits on the top of the head, a small dorsal fin, and a heterocercal non-bilobate caudal. The cephalic shield is, however, still without cornua.—Mr. Thomas Heath exhibited the photographs of the corona which he had taken during the total eclipse of May 28, 1900. The character of the corona was well marked in all; but from comparison with drawings taken by skilled draughtsmen it appeared that the outlying parts of the corona were not shown in the photographs. This might be due to the brightness of the sky consequent on the eclipse being one of short duration, or to the possible lack of actinic rays in these outlying regions.—Drs. D. Hepburn and D. Waterston read a paper on the true shape, relation and structure of the alimentary viscera of the common porpoise as displayed by the formal method. The animal on which the observations were made was an adult male, captured in fishing nets nearly eight months ago. It was carefully preserved within twenty-four hours of its capture, so that the organs retained their natural shapes and positions, while the various tissues were suitably "fixed" for microscopic examination. The authors have established, among other novel results, the presence of a peritoneal pelvic cavity which was not formerly recorded and which, from its relations to the vertebral column, provides a key to the subdivision of that part formerly called lumbosacral into lumbar and sacral sections. They have also revised the homologies of the multi-chambered stomach and placed them upon a more accurate footing; and similarly as regards the duodenum and intestine. The microscopic structure of the alimentary viscera was likewise examined under favourable conditions. The authors also report the presence of the tape-worm, *Bothriocephalus latus*, not hitherto recorded for marine animals.—Dr. A. T. Masterman communicated a paper on the central plexus of *Cephalodiscus dodecalophus*, M'I.

PARIS.

Academy of Sciences, July 22.—M. Fouqué in the chair.—The president announced to the Academy the death of M. de Lacaze-Duthiers, member of the section of zoology.—Remarks by M. Boussinesq on his work on the analytical theory of heat.—On the acidity of certain animal secretions, by M. Berthelot. In this study of acidity five indicators were employed—methyl orange, dimethylamidoazobenzene, red alizarine-sulphonate, litmus and phenolphthalein. Comparative determinations with these indicators were made of the acidity of the gastric juice, saliva and of urine.—Some observations made with uranium at very low temperatures, by M. Henri Becquerel. It was shown four years ago that between +100° and −20° C. there was no notable variation in the radiation from uranium, and in the present communication the intensity of this radiation is found to be practically constant at temperatures down to that of boiling liquid oxygen.—On the law of pressures in cannon, by M. E. Vallier.—New nebulæ discovered at the Observatory of Paris, by M. G. Bigourdan. Details of the positions and appearance of twenty-three new nebulæ.—On the Hermitian, by M. Léon Autonne. The name "Hermitian" is suggested instead of the "definite form" of Lœwy, and the properties of these functions are summarised.—On an application of potential functions to the theory of elasticity, by MM. Eugène and Francois Cosserat.—On the dielectric cohesion of gases; the influence of the walls, by M. E. Bouty. An experimental study of the disturbances produced by the walls of the vessel containing the gas under examination shows that the critical phenomenon, that is the point at which the discharge commences to take place, is altogether independent of the material of the walls. The action of the latter is indirect, in so far as it modifies in a more or less irregular manner the field in which the gaseous mass stands.—Gratings obtained by the photography of rigorously achromatic fringes, by M. G. Meslin.—On the nature of the X-rays, by M. Jules Semenov. From the experiments described the author concludes that the X-rays represent directions of transmission, by means of the ether, of electrical vibrations. These vibrations communicate themselves to all bodies which they meet in their course. When these bodies are charged with electricity and are protected against discharge by convection, they lose their charge by radiation.—The action of hypophosphorous acid upon acetone, by M. C. Marie. By the interaction of acetone and hypophosphorous acid two new crystallisable acids are obtained, the constitution of which is not yet determined.—The preparation of pure oxide of cerium, by M. Jean Stebba. By the use of electrolysis as a means of oxidation, the method of Wyrouboff and Verneuil is rendered more rapid. The oxide of cerium thus purified from other metals may have a distinct colour, but becomes snow white on completely eliminating the last traces of nitrogen.—The thermal study of the solid hydrates of soda, by M. de Forcrand.—The action of copper hydrate upon solutions of metallic salts, by M. A. Mailhe. With solutions of several metallic chlorides and bromides, copper hydrate gives a mixed basic salt.—The action of silver upon hydrobromic acid and the inverse reaction, by M. Jouniaux. The results obtained were generally parallel with those previously obtained with hydrochloric acid and silver, the value for the heat of reaction calculated from the equilibrium pressures at various temperatures being in practical agreement with the direct determinations of Berthelot.—The oxidation of propylglycol by *Mycoderma aceti*, by M. Andre Kling. The oxidising action of *Mycoderma aceti* upon propylglycol resembles that of the sorbose bacterium, the acetol, $CH_3.CO.CH_2OH$, being produced in both cases.—The action of the pyridine bases upon the tetrahalogen derivatives of benzoquinones, by M. Henri Imbert.—On the chlorides and bromides of the supposed binaphthylene-glycol, by M. R. Fosse.—The action of gaseous ammonia upon the chlorhydrates of fatty amines, by M. Felix Bidet.—On some new vegetable species of Madagascar, by M. E. Drake del Castillo.—Histological researches upon the sporulation of the Schizosaccharomycetes, by M. A. Guilliermond.—On the intracellular diastases of the Amœba, by M. H. Mouton.—Light from the phosphorescent bacilli of the Baltic, by M. J. Tarchanoff.—Electrical stimulation produced by two waves inverse to each other, by M. Georges Weiss.—On the yield of bread from flour, by M. Balland.—The utilisation of wine residues and wines useless through disease as manure, by M. F. Garrigou. The residues left after the distillation of wine, together with large quantities of wine spoilt through disease, are at present discharged into drains and rivers. In this way vast amounts of substances of considerable manurial value are wasted, and in the present paper methods are suggested for utilising these materials.

CONTENTS.

THURSDAY, AUGUST 8, 1901.

GREEK PHILOSOPHY AND MODERN CULTURE.

Greek Thinkers; a History of Ancient Philosophy. By Theodor Gomperz, Professor at the University of Vienna. Vol. i. Translated by Laurie Magnus, M.A. Pp. xv + 610. (London: John Murray, 1901.) Price 14*s.* net.

THE study of the history of Greek philosophy requires no defence and, fortunately, little encouragement. Confessedly our intellectual culture can be traced to Greek origin. The subject is so engrossing, and the full comprehension so indispensable, that able minds will be ever ready to consider the problem and give it fuller illustration. How far the questions that provoked discussion in the Greek colonies on the shores of the Mediterranean were intuitive, how far they were acquired, is of small importance in comparison with the manner in which they affect us. In these days, when the spirit of inquiry is active, we may doubt whether we tap the true source of originality by questioning Greek texts and obscure fragments. The spade of the archæologist is proving itself an equally potent factor. The sand-hills and tombs of Egypt have been made to reveal the secrets they have kept so well. Explorations among the ruins of ancient Babylonian or Assyrian cities have unearthed the traces of a highly developed civilisation on the banks of the Nile and the Euphrates which may have operated not less powerfully on the Greek colonists than the Greek philosophy has affected us. It may be that the student of the future, in his anxiety to trace the earliest effects on the human mind, will have to begin his criticism still farther back, but in the absence of any considerable literature we must at present be content to regard our culture as a Greek product.

Among those who have laboured diligently and with effect upon the many problems that exercised the ancient Greek, the researches of Prof. Gomperz will occupy a high place. His book entitled "Greek Thinkers," which appeared in 1896 and is now translated by Mr. Laurie Magnus, is an exceedingly welcome contribution to this subject. This work not only exhibits accuracy of scholarship and critical acumen, but is equally distinguished by lucidity of expression. Perhaps, too, we may say that Prof. Gomperz has been fortunate in his translator. It seems to us that Mr. Magnus has accomplished his part of the work with admirable skill, and that to an English reader the charm of the work is greatly increased by the ease and brightness with which the original thoughts of the German writer are expressed. Prof. Gomperz deserved a good translator. He has done much useful work himself in making his countrymen acquainted with the thoughts and philosophy of J. S. Mill through translations, and it is only fitting that a similar service should be rendered to his monograph.

The main object of Prof. Gomperz's work is, it may be assumed, to show how greatly, and in what particular directions, we are indebted to Greek thought and Greek methods. Of course, as a general principle the effect is admitted, but to trace the connection with any degree of completeness is a matter of no small difficulty. It requires a survey as a whole of the developed intelligence of the Greek mind, an appreciation of the different tendencies of ancient thought, and a very complete knowledge of modern culture. The author thinks it not impossible that in the future we may see an exhaustive universal history of the mind of antiquity. Pending the appearance of such a monumental work, we welcome with gratitude the worthy contribution that is here made to the more general scheme to which it forms an adequate introduction.

In an introductory chapter the author unfolds, as a panorama, the theatre in which all future development was generated. He dwells appreciatively on the effect colonial life and experience exercised on the intelligence and vigour of the nation, fostering, on the one hand, the hardy and courageous disposition of the emigrant; and, on the other, enlarging his horizon and stimulating his ambition by travel and contact with foreign civilisation. It was in the colonies, doubtless from the introduction of the foreign element referred to above, that the greatest intellectual vigour was afterwards found. To them more than to the parent state it was given to steep themselves in intellectual pursuits, and with whom the riddles of the world and of human life were to find a permanent home and to provoke an enduring curiosity.

The author divides his book into three sections—The Beginnings, From Metaphysics to Positive Science, The Age of Enlightenment. Such a division must of necessity be a little arbitrary, suggesting greater breaches of continuity than really existed. Also, at times, it may lead to a little confusion in chronological arrangement, but that is of small importance, since progress never exhibits the uniform onward movement we connect with time. Historical or biographical references when introduced simply play a secondary part as a background, to give effect to the ordered development. As earliest in history, but perhaps more advanced in scientific accuracy, containing, as it did, the accumulated information of the priests of Chaldea and Egypt, the Ionian school comes first under review, and well exhibits the author's general method of treatment. He endeavours to find the principle underlying the original expression, to think as these old philosophers thought, to determine the amount of truth at which each arrived, to give him credit for it, and to compare and contrast it with modern views. In the Ionian school, for instance, we have hitherto, perhaps, too much considered the astronomical teaching, a result of the commanding importance which Thales has acquired, owing to the part the famous eclipse connected with his name has played in scientific chronology. This has introduced a disproportion which is fatal to a general survey. We have forgotten that he also taught that water was the primary element. To have the true measure of the time we have to remember him as a chemist as well as an astronomer. Prof. Gomperz finds in the teaching of this school, underlying the vagueness, two of the corner-stones of modern chemistry—the existence of elements and the indestructibility of matter. At another point the "physiologists" of Ionia actually outstripped the results of modern knowledge. The bold flight of their imagination never rested "till it reached the conception of a single fundamental or primordial matter as the source of material diversity" (p. 46). Prof. Gomperz's comment is, "Here it may almost be said that inexperience was the mother of wisdom." We are inclined to agree with him, though possibly not quite in the sense in which the phrase is used. The scientific teaching of the school seems to have been best at its birth, and rapidly to have deteriorated. But while admitting and appreciating the author's wish to give credit to whatsoever things are true and of good report, difficulties and uncertainties must exist owing to the scarcity of original documents. We get the views of the great thinkers of antiquity filtered through the minds and coloured by the influence of a crowd of disciples, of collectors, of commentators. The author admits that the whole pre-Socratic philosophy is one vast field of ruins. The picture constructed from these scattered mosaic fragments may be very beautiful to look at, but it may not be the same picture that was originally drawn.

We should have liked to follow the author through each school in which he discovers the different tendencies of ancient thought or given some evidence of the discriminating appreciations that have accompanied some time-honoured name. One could linger long over the Eleatics, those pioneers of criticism who sought to rouse mankind from indolence of thought and the disposition to dogmatic slumber. For the paradoxes of Zeno we have always entertained a profound veneration, and the author is kind enough to stir these dry bones and make them live. Some of these he has clothed in a modern dress, but the difficulty does not lie in the dress, and the old problem connected with relative and absolute motion seems as elusive as ever. The tale of the arrow sped from the bow is put into this captious form: "Does an object move in the space in which it is, or in the space in which it is not?" And this seems as good a way as any to put the problem, which does not seem to have been clearly expressed in the original. Similarly with the old, old story of Achilles and the tortoise, to which we believed we could have given a satisfactory answer before reading the author's comments, but now entertain grave doubts. It is a difficult task to frame a paradox which cannot be exploded in less time than it takes to construct it, and the ingenuity of Zeno will be appreciated by those who have attempted to follow him on this thorny path.

The historians and the physicians or medical schools must also be passed over in silence, though it cannot be imagined that in a critical account of Herodotus, for example, there is not much to interest and perhaps something to qualify. The importance of the medical schools is insisted upon, since here exact observation supplied a much needed check to hasty generalisations, and many a forgotten name to whom accident has denied justice appears in this list of worthies, all contributing to build up science as we understand the term. A work of some 600 pages by a German author might be supposed by some to be a very dull work. This would certainly be an error. It is bright and lucid, free from pedantry, and occasionally epigrammatic. Prof. Gomperz promises us two more volumes; we have no doubt but that the interest will be equally well sustained, and we hope he may again meet as pleasant and competent a translator.

MEDICAL AND SURGICAL EXPERIENCES IN THE SOUTH AFRICAN WAR.

A Civilian War Hospital; being an account of the work of the Portland Hospital, and of experience of wounds and sickness in South Africa, 1900, *with a description of the equipment, cost and management of a civilian base hospital in time of war.* By the Professional Staff. Pp. 343. (London: John Murray, 1901.)

THE Portland Hospital was a hospital organised and equipped by voluntary effort in this country for service in South Africa. It was the first of several similar hospitals sent out after the declaration of war in October 1899; but it was not the first voluntary hospital ever attached to a British Army at the front, as the authors suggest in their preface. One well-known hospital, for example, the hospital which is now the British Hospital at Port Said, was originally established as a voluntary hospital for the sick and wounded of the Egyptian Campaigns. The Portland Hospital, however, has the credit of being the first example in this country of a voluntary undertaking on behalf of the sick and wounded being placed entirely in the hands of the military medical authorities for organisation, equipment and management. Formerly the promoters of such undertakings preferred to act independently and, as a matter of fact, to run counter to official medical authority, believing that their usefulness would be in proportion to the extent to which they could over-ride the restrictions imposed by military discipline and control. Continental nations have long ago recognised the folly of this conception, and the Portland Hospital has the merit of having led the way in this country towards a loyal recognition of the necessity of voluntary aid in war becoming an integral part of the military medical organisation. The dedication of the volume to the Principal Medical Officer of the Field Force and to the Officers of the Military Hospital, to which the Portland Hospital was attached, indicates the success of this more modern conception of the value of voluntary aid in war.

The Portland Hospital may, indeed, be regarded as civilian only in name and in the fact that its professional staff consisted of Mr. Anthony Bowlby, Dr. Howard Tooth, Mr. Cuthbert Wallace and Mr. J. E. Calverley, and that the cost of its equipment and maintenance was defrayed from private sources. In other respects it was a distinctly military organisation under an Army medical officer, Surgeon-Major Kilkelly of the Grenadier Guards, and was, in fact, a fifth section of the military establishment known as a general hospital at the base.

The gentlemen named are the authors of this volume, and they have achieved their task admirably. The opening chapters and several voluminous appendices form about one-third of the book and describe the personnel, equipment and interior economy of the hospital. It can scarcely be said that they open up fresh ground or present new facts for consideration. The remaining chapters contain an excellent and valuable record of the medical and surgical work done in the wards of the hospital or in the wards of other hospitals to which the staff of the Portland Hospital had access.

The medical work is recorded in two chapters by Dr. Tooth and Mr. Calverley. The first and more important of these chapters contains an account of the authors' experience of enteric fever and simple continued fever in South Africa. But most of the scientific interest attached to this subject has already been exhausted in a paper by Dr. Tooth which was read and discussed quite recently before the Clinical Society of London, and the chapter is more or less a repetition of that paper. Some interest, however, will be felt in the attitude of the authors towards "simple continued fever," which they express in the statement that a diagnosis of simple continued fever "is little more than a confession of ignorance," but "must be tolerated in the absence of more exact knowledge." In their experience, all such cases were cases of exhaustion, diarrhœa, dysentery, insolation or true enteric fever, and they consider that a medical officer assumes a rather dangerous position in diagnosing a case as "simple continued fever" simply because he does not know what the fever is and does not think it is enteric. All thoughtful physicians will readily acknowledge that there is a general lack of exact knowledge regarding fevers of this kind. In military medical practice these fevers are extremely numerous and seldom fatal, and the term "*febricula*," which was included in former editions of the "Nomenclature of Diseases," issued by the Royal College of Physicians, best indicated the type of fever described and was a less confusing term to use for what was, after all, a symptom rather than a definite disease and for what must necessarily be a provisional rather than a positive diagnosis. It is evident, however, that, in the authors' experience, a large number of these cases were considered to be mild forms of enteric fever. The Board of Medical Officers appointed to inquire into the outbreak of enteric fever in the camps of the United States Army in 1898 came to a similar conclusion; and, if it becomes the fashion to record this type of fever as enteric fever instead of as simple continued fever, we must be prepared for some remarkable variations, statistically, in the incidence and case mortality of the former disease.

The second chapter on medical subjects deals with diarrhœa, dysentery, sunstroke, diseases due to exposure, functional diseases and mental disturbances as experienced in war. It will repay perusal, but can scarcely be described as important. The facts are commonly known and have frequently been described in the medical histories of campaigns. It may, however, be interesting to note that the authors consider diarrhœa and dysentery to be synonymous. "Dysentery," they say, "is diarrhœa writ large,' or, in other words, the two have a common origin." Their reasons for adopting this opinion are not convincing. In fact, no reasons are given other than some vague theories and speculations regarding the probable cause of the well-known diarrhœa of campaigns.

The best feature of the volume from a scientific standpoint is the record of surgical work; and the chapters on this subject, to which nearly one-half of the book is devoted, will cause it to take a high and important place in the literature of military surgery. They are written by Mr. Bowlby and Mr. Cuthbert Wallace, and are characterised, pre-eminently, by thoughtful and careful observation of fact. Hitherto our scientific knowledge of the effects of modern fire-arms has been dependent on experiments, notably those of Prof. Bruns of Tübingen. Mr. Bowlby and Mr. Wallace have at once lifted us from the sphere of experiment into that of actual facts by a series of observations the accuracy and completeness of which are forcibly impressed upon the reader. Briefly, their facts may be regarded as confirming the observations and conclusions of the experimentalists. They had opportunities of observing side by side wounds made by the Mauser and old Martini rifles, both of which were used by the Boers. The modern "perfect" bullet, the bullet with hard mantle and small calibre, causes less shock, both local and general, than the old bullet, and the risk of sepsis is diminished. But the high velocity of the former at short ranges is disastrous and is the cause of the so-called "explosive" effect. The authors' explanation of this is that the energy of the bullet is transmitted to the tissues, and they base this explanation on the symptoms and after-effects of wounds observed by them in which the injury was not confined to the immediate track of the bullet. The tissues beyond were found to be profoundly injured, and these widely-spread effects were largely in proportion to the velocity of the projectile. Thus, in the brain the passage of a bullet at close range is found to result in the disintegration of almost all the cerebral mass, while a certain proportion of patients shot through the brain at extreme ranges made satisfactory recoveries. In bones, too, the effect of high velocity at short ranges is to produce very extensive splintering and pulverisation, whilst at long ranges cancellous bone may be simply perforated and compact bone fractured with but little comminution. These observations completely confirm Bruns' experiments, and they will be quoted as essential facts in future text-books on military surgery.

As regards another well-known phenomenon, fragmentation and alteration in the shape of bullets, the authors' observations lead them to believe that this does not occur, in the case of hard mantled bullets, except as a result of ricochet and impact with hard substances outside the body, a probable explanation which has been overlooked in some recent continental works on the effect of modern fire-arms. Another important observation is that soft-nosed or "sporting" bullets do not "set up" on impact with soft tissues, and only when they hit hard bone. Sportsmen will be inclined to disagree with this, but the authors point out that the hide of big game is compact enough to cause "setting up" of a soft-nosed bullet, whereas the human skin is not.

These are only a few of many interesting and important observations made in the chapters on the surgical work of the hospital. In pages devoted to bullet wounds of blood-vessels, nerves, joints, head and abdomen there are points of special interest and value, which throw a flood of light on many questions connected with the surgical work of modern wars, and which every surgeon, certainly every military surgeon, should study.

The volume is profusely illustrated by photographs, including some skiagraphs, which add greatly to the interest and value of the book. It also contains a useful index.

W. G. M.

A CATALOGUE OF PALÆARCTIC LEPIDOPTERA.

Catalog der Lepidopteren des Palaearctischen Faunengebietes. I Theil: Famil. Papilionidæ—Hepialidæ. Von Dr. O. Staudinger und Dr. H. Rebel. Pp. xxxii + 411; portrait; II Theil: Famil. Pyralidæ—Micropterygidæ. Von Dr. H. Rebel. Pp. 368. 8vo. (Berlin: R. Friedländer und Sohn, Mai 1901.) Price Mk. 15 (paper); Mk. 16 (cloth).

THE publication of the third edition of Staudinger and Wocke's Catalogue of Palæarctic Lepidoptera is an event of considerable importance. In the earlier part of the last century, the catalogues of European Lepidoptera most in use were those of Boisduval, who published the first edition of his "Index Methodicus," including Papilio, Sphinx, Bombyx and Noctua (in the Linnean sense), in 1829; and the second edition, to which the Geometridæ were added, in 1840. The latter edition included 1941 species, among which are enumerated the few species then known from the Caucasus and Siberia; for Continental entomologists have always treated the insects of the adjacent countries as virtually forming part of the European fauna. In 1844 Duponchel published a more elaborate "Catalogue Méthodique des Lépidoptères d'Europe" (pp. xxx + 523), including the whole Order.

Between 1843 and 1851 the German entomologist, Heydenreich, published three editions of his "Systematisches Verzeichniss der europäischen Schmetterlinge," the last of which extends to 130 pages, double columns; and the first edition of the "Catalog der Lepidopteren Europa's und der angrenzenden Länder, I. Macrolepidoptera, bearbeitet von Dr. O. Staudinger; II. Microlepidoptera, bearbeitet von Dr. M. Wocke" was issued in a nearly similar form to Heydenreich's. It was published in Dresden in September 1861, and includes pp. xvi + 192 (double columns). This catalogue includes 5250 species in all; and the 1941 species of Macrolepidoptera enumerated by Boisduval in 1840 proved to have increased, in little more than twenty years, to 2583. This catalogue was very complete and carefully compiled (especially in its earlier portion, for Dr. Wocke's work is far inferior to Dr. Staudinger's), and it at once took its place as the standard catalogue of European Lepidoptera. This edition included no localities; but those species which did not occur within the geographical limits of Europe were marked with an asterisk. The title pages and preface were duplicated in French and German.

In another ten years (January 1871) a second and greatly improved edition was issued (pp. xxxviii + 426)—this time in single pages, except that a side column is devoted to full localities of each species and variety. The number of species enumerated had now risen to 2849 Macrolepidoptera and 3213 Microlepidoptera, or 6062 in all. The catalogue includes the species of Europe, North Africa, Asia Minor, Transcaucasia, Siberia as far as the Amur, and Greenland and Labrador, but is yet very far from including the whole of the Palæarctic region; for Dr. Sclater's epoch-making paper on the geographical distribution of the class Aves was only published in vol. ii. of the *Journal* of the Linnean Society in 1858, and did not attract the attention of entomologists till some years afterwards.

This second edition of 1871 has long been out of print, and for many years Dr. Staudinger had been making preparations for a new edition, to include the bulk of the Palæarctic fauna, a work rendered much more arduous by the immense increase in entomological literature, as well as by the large number of new species discovered during the last thirty years. The work has, however, been finally carried to a successful conclusion by Dr. Rebel, Dr. Staudinger's old colleague, Dr. Wocke, having predeceased him by some years.

The present edition includes a portrait of the late Dr. Staudinger, a German preface by Dr. Rebel, chiefly relating to the preparation of the work, a tolerably full bibliography and list of geographical names, and a sketch of the system adopted, which, we may say, without being absolutely revolutionary, exhibits profound modifications from that used in the earlier editions of the catalogue. Then follows the bulk of the work, comprising (allowing for supplementary additions) 4756 Macrolepidoptera and 4963 Microlepidoptera, or 9719 species in all.

The present catalogue now includes the Lepidoptera of the greater part of the Palæarctic region and the circumpolar region. Among the most important additions to the districts included in the second edition are the Nile Delta to Cairo; Asia, to the northern frontiers of Thibet, and the lower course of the Hoang Ho to the Chingan Mountains; North Manchuria and the whole district of the Ussuri; North Japan (not southern Japan, in which case Corea and the greater part of China must also have been included); Central Asia, Palestine, Persia, &c. A few varieties of species noticed, which occur beyond these limits, have also been included. These are marked with an asterisk; but we regret that the strictly European species are not, as in previous editions, indicated by the presence or absence of any special mark.

Dr. Rebel appears to have done his work very completely, English and other works published in 1900 being quoted in the addenda. We notice references to pp. 552 and 581 of the *Transactions* of the Entomological Society of London for that year.

The two parts of the work are separately paged and have separate title-pages, but are bound in one volume. The indices are very bulky, occupying no less than 102 pages of the second volume; the index of families and genera fills sixteen pages, in double columns; and the index of species, varieties, aberrations and synonyms fills no less than 86 pages of very small type in triple columns.

We need hardly say that the work before us will be an absolutely indispensable handbook to all Lepidopterists who are working at any part of the Palæarctic fauna for many years to come—probably till it is superseded by a new edition. At the same time, we cannot expect any book to be absolutely complete or faultless. To have made the bibliography complete would have been impracticable, and we notice that some books not included in it are quoted in the catalogue. Again, we notice the omission of various varietal names; but some entomologists consider that the naming of varieties has been carried much too far of late years, both in Lepidoptera and in

Coleoptera. A certain amount of discretion as to what to include and what to omit, as well as in the selection of synonyms, must be conceded to every cataloguer. A few misprints are corrected at the end of the book, and we have noticed others; but they are not of a character to interfere in any way with the usefulness of the book, and an occasional misprint is absolutely unavoidable in a work of such an extent, and including such a vast amount of minute detail. W. F. K.

AN EPITOME OF MODERN CHEMISTRY.

Modern Chemistry. Part i. *Theoretical Chemistry.* Pp. 126; Part ii. *Systematic Chemistry.* Pp. 203. By William Ramsay, D.Sc. The Temple Primers. (London: J. M. Dent and Co., 1900.) Price 1*s.* each.

GIVERS of inexpensive Christmas remembrances—something more than a card and less than a present—have made us very familiar with the small volumes of the Temple series, and at a first glance the title pages of the two books before us seem to promise selections from Epictetus or De Quincey rather than an exposition of modern chemistry by a living authority. In the first of the volumes Prof. Ramsay has given an extremely condensed account of the present state of chemical theory, and in the second an equally condensed account of systematic chemistry. Both books bear the marks of freshness and originality, and, it must be added, both produce a certain feeling of breathlessness. They are eminently readable to a chemist, and extremely interesting as displaying a sort of camera obscura picture of the territory of chemistry as it is presented in the mind of one of the most active, most unconservative and most distinguished of contemporary workers.

The question that forces itself most persistently upon a critic is—for what class of readers are these books intended? They are called primers, and the present writer, wishing to fortify his opinion that a primer was essentially a book for beginners, has found, on reference to a dictionary, that a primer is "a small elementary book for religious instruction or for teaching children to read." He has, further, taken the trouble to put one of these primers into the hands, not of a child, but of a friend of more mature years and not wholly strange to scientific notions, with the request that he would see what he could make of it. The answer came quickly and in unmistakable terms. The word primer has really no justification in connection with these books; they are in no wise suited to beginners. To those who are working in one little corner of chemistry with their eyes averted from all that is going on elsewhere, and to workers in other sciences who at one time have known a fair amount of chemistry, Prof. Ramsay's survey may be just what they have been wanting. Considering the limits of space imposed, he has given a wonderfully complete and connected account of the state of modern chemistry. The book on theoretical chemistry is naturally the more readable of the two, and it forms a more continuous story. The systematic chemistry exhibits and classifies the facts of chemistry in a way which is striking and interesting and well suited for retrospective purposes. Stress must be laid upon this last qualification, for it is to be feared that a reader who had not already a very good grounding of chemistry would be unable to make any headway in the subject if he started along the lines on which Prof. Ramsay has achieved his formidable task.

To those who wish to refresh their knowledge of chemistry or to look at it from a new point of view, and to those who wish to gain some idea of the very important changes which have been affecting the whole science during the past fifteen years, Prof. Ramsay's little book may be warmly recommended. Such readers will carry away some knowledge at least of "phases," electro affinity, the later developments of stereochemistry and many other innovations; and they will see, with mixed feelings perhaps, how the modern electrochemical theory is changing the whole language of the science.

A. S.

OUR BOOK SHELF.

Essays, Descriptive and Biographical. By Grace, Lady Prestwich. With a memoir by her sister, Louisa E. Milne. Pp. 266. (Edinburgh and London: William Blackwood and Sons, 1901.) Price 10*s.* 6*d.*

LADY PRESTWICH, who survived her husband, Sir Joseph Prestwich, but little more than three years, died in 1899 at the age of sixty-six. They were married in 1870, and settled at Shoreham, near Sevenoaks, in the charming house of Darent-Hulme, built by Prestwich. While he was professor of geology at Oxford, many months in each year were spent in that ancient home of learning, and there Prestwich was constantly assisted by his wife in the preparation, not only of his standard work on geology, but also of his lectures, diagrams and geological papers. Herself an authoress, she had exhibited considerable literary ability in her two novels, "The Harbour Bar" and "Enga," and in a number of essays printed in *Good Words*, *Blackwood's Magazine*, the *Leisure Hour*, &c. Some of these are here reprinted. There are "Recollections of Boucher de Perthes," being the history of the discovery of Palæolithic implements; "Evenings with Madame Mohl," or reminiscences of a Paris salon; "An Evening with Mrs. Somerville"; some account of the parallel roads of Glen Roy, and essays on physiography, all pleasantly and instructively written. One article not previously published is on the old almshouse of Ewelme, and another is on the Findhorn, especially attractive to Lady Prestwich, as her earliest home was in Morayshire, on the banks of this, perhaps the grandest of Scottish rivers.

In the memoir, which has been attractively written by Miss Louisa Milne, we have the record of the life of a good and highly cultured woman, a life comparatively uneventful, it is true, but the record will be found full of interest to those who had the privilege of knowing Lady Prestwich, while others who peruse this volume will derive instruction, always pleasantly conveyed, and make acquaintance with a charming personality. Amid her many occupations, Lady Prestwich found time for much active benevolence and for work relating to the higher education and employment of women. In her younger days she travelled much with her uncle, Dr. Hugh Falconer, and reminiscences of these journeys are extracted from her diary. An interesting essay on "our white deal box" tells the story of the trouble they had in passing this box through the custom-house at Naples, as it contained mysterious plaster casts of the head and bones of a rhinoceros. Even the letters F.R.S. after Falconer's name puzzled the officials. "Royal Society sounded well, but how was the word Fellow to be rendered in French or Italian? I had to be careful, since it could be interpreted in more than one sense. A little heedlessness on my part might bring on my uncle the same sentence as was passed in another Italian town on a Cambridge don who had 'Senior Wrangler' inscribed on his passport. The police translated it as 'inveterate brawler'! and he was in consequence denied permission to travel, and was detained eight days before being allowed to proceed."

Chemical Lecture Experiments. By Francis Gano Benedict, Ph.D. Pp. xiv+436. (New York: The Macmillan Company, 1901.)

THE days of that ancient bugbear, the "Guide to Knowledge," containing in the form of questions and answers a concise *résumé* of all "the scientific facts that a well-educated boy or girl should have learnt," are fast coming to an end. Dr. Benedict has struck another blow at them in issuing his manual of "Chemical Lecture Experiments." The aim of the book is to furnish teachers with a set of trustworthy experiments which can be carried out with ordinary, simple apparatus, all others being rigorously excluded.

It is unnecessary nowadays to comment on the value of experimental demonstrations in a lecture-room, and, as the author points out in his preface, it is unwise to neglect them and trust entirely to laboratory exercises. The latter, "however great their influence in developing the experimental side of teaching the science, have their limitations experimentally and educationally, and cannot supplant the experimental lecture, for it is in the lecture, and there only, where each experiment stands out clearly defined and unattended by the distractions necessarily accompanying laboratory exercises, that the first accurate observations of chemical phenomena can be made by students."

The testimony and example of such illustrious teachers as Bunsen, Liebig, Victor Meyer, and in our own day of Ostwald, Fischer and Moissan, are arguments strong enough to overcome any objections, and Dr. Benedict is to be congratulated on his efforts to lighten the task of the overworked and much-abused teacher. Although he may not be able to lay claim to any great originality, the field having already been pioneered by Arendt and Heumann and Newth, he has succeeded in collecting a good series of experiments to illustrate an elementary course of inorganic chemistry, which, by reason of the careful descriptions and clear diagrams, will commend themselves to all who are conducting classes with only a very limited supply of apparatus and means.

A Manual of Laboratory Physics. By H. M. Tory, M.A., and F. H. Pitcher, M.Sc. Pp. ix + 284. (New York: John Wiley and Sons, 1901.)

THE rapid extension of the study of practical physics in recent years is shown by the number of books which have been published lately dealing with this subject, but we cannot say that much originality has been shown either in the mode of treatment or in subject matter. The exercises are generally those with which teachers are well acquainted. In this book the object of the authors has been to compile notes which will save the demonstrator as much separate explanation as possible. It will therefore be of use in laboratories where funds do not permit many assistant demonstrators to be employed.

The book deals with the whole of physics except mechanics and hydrostatics. Each exercise is divided into the following sections: References to books dealing with the special phenomenon; apparatus required; theory of the experiment; practical directions; example; and a blank to be filled in by the student.

There are a few points about which a word or two may be said. We should have liked to have seen more stress laid on the necessity of students recording the precise nature of the quantities in terms of which their measurements are made. It is not well for them, for example, to see the velocity of sound expressed as 34230 cm. Some of the diagrams leave much to be desired; that of the trace left by a tuning-fork on a falling smoked plate is strangely irregular. The present writer has not tried this experiment under the conditions shown in the figure, but he would expect to get a more intelligible record. The trace obtained with the pendulum-chronograph is also very unlike what we should expect.

The simple wire bridge for measuring resistances is described as the B.A. bridge. We were under the impression that the particular modification introduced by the committee of the British Association was that in which arrangements were made for using Carey Foster's system of interchanging a pair of nearly equal coils.

A good deal of attention is given to the testing and calibration of ammeters. This is very useful to those students going on to the engineering side of physics.

It may be of interest to consider the directions in which a development of practical physics teaching may be expected. There seem to be two ways open for this to take place. The first is to make the laboratory exercises follow precisely the course of lectures, so that the student performs experiments which illustrate what he has been taught in the lecture. This is the rational way of coordinating the teaching and practical work, but it is open to the objection that a much larger stock of apparatus is required. The second direction of development is to allow the student to make the greater part of his apparatus, and this forms the best training for research. Such books as Prof. Threlfall's "Laboratory Arts" is a step in the latter direction, whilst some of the modern more elementary text-books are on the former plan.

In another way this book is of interest to us, as it shows the standard of work reached in the elementary classes in the McGill University, where the physical laboratory is one of the finest and best fitted departments. So far as one can judge, the standard is much the same as in similar classes at home. S. S.

The Story of Wild Flowers. By Rev. Prof. G. Henslow, M.A., F.L.S., F.G.S., &c. With forty-six figures in text. Pp. viii+249. (London: George Newnes, Ltd., 1901.) Price 1*s*.

THIS interesting little book contains much more than its title might seem to imply, since it treats, not only of flowers, but also of the lives and forms of flowering plants, their distribution and evolution. Though both readable and instructive, this booklet loses much in value as a trustworthy popular introduction to botany because its author has elected to saturate it with the extreme form of neo-Lamarckism, of which he is so fervid and, in this country, so isolated an advocate. Much of Prof. Henslow's treatment of the subject is refreshing, and in this respect the chapters on stipules and on vegetative sports, as well as the occasional references to horticultural operations, are especially worthy of note. The author's views on morphology do not, however, always accord with modern opinions; he writes, for instance, "The leaf usually consists of two parts, the leaf-stalk . . . and the blade . . ." (p. 64). "The homology of bracts is various. They may be *stipular* as in Magnolias, more generally are *petiolar* as in Hellebore . . ." (p. 97). Other not generally accepted views are those expressed in reference to the cause of the rosette-form of "high Alpine plants" (p. 103), the significance of circumnutation in twiners (p. 100), and the object of movements of leaves (p. 104). But most open to criticism are the explanations offered of the origin of certain structural and habitual features by the inheritance of the effects of repeated stimuli. In the second volume, on non-European flowering plants, which the author half promises, it is to be hoped that attention will be directed rather to the well-tested facts of evolution than to mere hypotheses as to the precise causes of evolution in special cases.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Hair on the Digits of Man.

THE distribution of hair on the dorsal surfaces of the digits in man, anthropoid apes and monkeys, is referred to by Romanes in "Darwin and after Darwin," but its significance seems to be overlooked. I would venture to suggest that these facts bear a Lamarckian, and only a Lamarckian, interpretation. It is clear that if acquired characters can be inherited through use, habit or environment, the loss of certain characters through habit and the like may also be inherited, and the development of characters on the one hand and the decay of characters on the other will be sufficient to prove that Weismann's great rule is not absolute. Use-inheritance and disuse-inheritance ought both to be capable of proof. It may be difficult, or impossible, to *prove* the greater cases, such as the long cervical vertebræ of the giraffe and the great horns of the elk, and indeed most of the instances brought forward by Herbert Spencer, Eimer and Cunningham. These may lie open to a selectionist interpretation. But it becomes well-nigh impossible to carry such an interpretation into the trifling biological characters to which I would briefly refer.

In man, hair is entirely wanting on the ungual phalanges of his hand and foot, very rare on the middle phalanges of either foot or hand, and always present more or less on the first row of phalanges in both foot and hand. On the middle phalanges, where it occasionally occurs, it is best looked for in early childhood, when the hair is more strongly developed than in infancy, and when it has not yet disappeared through secondary causes. I have just examined the case of a child of four and a half years old with marked hair on the middle phalanges of the four digits on the hand, and on the second, third and fourth digits of the foot, and with *none* on the fifth digit, except on the first phalanx. It is worthy of remark here that many of the facts of hair-direction, being somewhat fugitive in character, are best studied in the human subject in childhood.

Assuming that man is the child of the monkey, it follows that his ancestors possessed at one time hair on all the phalanges of both foot and hand, as is the case in all the existing monkeys of the Old World and New World that I have been able to examine; though a Chacma baboon at the London Zoological Gardens shows abundant hair on all the phalanges of the foot, and on the middle and ungual phalanges of the hand either no hair or the small amount that is present very much worn down. In the few anthropoid apes that I have been able to examine, the chimpanzee resembles the human subject in this character, and the young orang at the Zoological Gardens possesses hair like that of the lower monkeys, *i.e.* on all the phalanges of foot and hand, though on the two terminal phalanges of the hand the hair is worn down and quite bristly, even though the animal is still young.

Broadly speaking, these facts are congenital and must be acquired, either through heredity, variation and selection, or as the result of habit, such as that of friction, acting through numerous ancestors in a similar direction. We need only bear in mind how much greater is the exposure to friction, in the movements of the hand of man, of the ungual and middle phalanges than that of the first phalanx to see that the conclusion as to the Lamarckian view here put forward is difficult to resist.

This very small point seems to be more worth considering than its intrinsic importance would warrant, in consequence of the way in which a disputed biological doctrine, such as that of Weismann, is being exploited in a somewhat serious matter. It is enough to quote W. K. Brooks, of America, and Prof. J. Arthur Thomson, of Aberdeen, in support of the statement that Weismann's doctrine is "not proven." I refer to the long and somewhat heated discussion which has taken place recently in the columns of the *Lancet* on the subject of "Legislation against National Intemperance." The greater vigour of assertion and multitude of words, if not greater logic, rests with the advocates of the view that alcoholism is a selective influence of value in the evolution of man and ought not to be interfered with by legislation. The reasons for this startling contention are numerous, but their justification rests ultimately on the doctrine of Weismann carried to the bitter end, viz. that acquired characters are not inherited. I submit that if it can be shown that no other than a Lamarckian interpretation of certain small phenomena is possible, something may be done towards making a breach in a somewhat dangerous citadel. WALTER KIDD.

July.

Pseudoscopic Vision without a Pseudoscope: A New Optical Illusion.

A METHOD of securing an illusion of binocular vision wholly without instrumental aid occurred to me recently, which is interesting in connection with the study of pseudoscopic vision. It is fully as startling as any of the results obtained with the lenticular pseudoscope, which I showed at the Royal Institution in February, 1900, and which I shall speak of presently, and, requiring the aid of no optical instrument, is much more impressive.

A lead pencil is held point-up an inch or two in front of a wire window screen, with a sky background. If the eyes are converged upon the pencil point, the wire gauze becomes somewhat blurred, and of course doubled. Inasmuch, however, as the gauze has a regularly recurring pattern, the two images can be united, and with a little effort the eyes can be accommodated for distinct vision of the combined images of the mesh. To accommodate for a greater distance than the point upon which the eyes are converged requires practice, but the trick is very much easier in this case than in the case of viewing stereoscopic pictures without a stereoscope.

As soon as accommodation is secured, the mesh becomes perfectly sharp and appears to lie nearly in the plane of the pencil point, which still appears single and perfectly sharp. If now the pencil is moved away from the eyes which are to be kept fixed on the screen, it *passes through the mesh and becomes doubled*, the distance between the images increasing until the point brings up against the screen. If now the pencil be removed it will be found that the sharp images of the combined images of the gauze persists, even though the eyes be moved nearer to, or farther away from, the screen. Bring the eyes up to within six or eight inches of the plane in which the mesh appears to lie and attempt to touch it with the finger. *It is not there:* the finger falls upon empty space, the screen being in reality a couple of inches further off. This is by all means the most startling illusion that I have ever seen, for we apparently see something occupying a perfectly definite position in space before our eyes, and yet if we attempt to put our finger on it we find that there is nothing there.

It is best to begin by holding the pencil an inch or less in front of the screen. As the eyes become accustomed to the unusual accommodation, the distance can be increased. I have succeeded in bringing up the apparent plane of the mesh, five or six inches, but this requires as great a control over the eyes as is necessary in viewing stereoscopic pictures without an instrument.

The pseudoscope, which I have alluded to above, I have described in *Science* (about November, 1899), but inasmuch as the description of it which I sent to NATURE, the editor informs me, was never received, a brief account of it may not be out of place. Two lenses of about three inches focus are mounted in front of a pair of stereoscope lenses in such a way that the real inverted images formed by them in space can be combined by the stereoscope. The lenses should be mounted in slide tubes attached to the frame of the stereoscope, so that proper focussing can be accomplished. This instrument has been named the lenticular pseudoscope by the psychologists, and gives results far superior to those obtained by the Wheatstone and other forms of mirror pseudoscopes. Viewed through the instrument, a hollow bowl appears as a beautifully convex dome, and if a marble be dropped into it we witness the astounding phenomenon of a ball rolling up hill, crossing the top, descending part way down the other side and then returning to the summit, in defiance of the law of gravitation.

Johns Hopkins University. R. W. WOOD.

Markings on Jupiter.

THERE is a large, dark spot on the southern side of the S. equatorial belt (and nearly in same latitude as the red spot) which on July 24 was preceded by a number of small black dots 5° to 10° apart, according to the observations of Dr. Kibbler, of Stamford Hill, who appears to have been the first, or one of the first, to discern these interesting markings. The largest spot seems to be drifting westwards, relatively to the zero meridian (System II.) of Mr. Crommelin's ephemerides, at the same rate as the S. temperate zone of Jupiter, viz. 16 degrees per month. On August 3 I observed the spot in transit at 8h. 56m., hence its longitude was 232°·8. If the westerly drift of the object is continued and its existence sufficiently prolonged, it will arrive at conjunction with the following end of the red spot in July, 1902, the longitude of the latter being about 46°. This value has shown little variation during the last twelve months.

The new marking deserves special notice from the fact that a conspicuous spot appeared in about the same latitude in the summer of 1889 and formed the subject of an interesting paper by Mr. A. S. Williams in the *Monthly Notices* for June, 1890. This spot, when its more rapid motion enabled it to overtake the red spot, was diverted southwards and its material flowed along the southern edge of the ellipse, afterwards drifting further west, freeing itself from the red spot, and finally appearing as a well-defined red streak or short belt. The present disturbance may indicate a recurrence of the phenomena of twelve years ago, and it is desirable that its future developments be closely watched. The chief spot will be central at about the following times:—

	h.	m.
August 10	9	35
,, 12	11	11
,, 15	8	38
,, 17	10	15
,, 20	7	42
,, 22	9	18

Bristol, August 4. W. F. DENNING.

MEASUREMENTS OF SOLAR RADIATION.[1]

IT is impossible within the limits of a short notice to give any detailed description of Prof. S. P. Langley's great work, contained in his first volume of the "Annals of the Astrophysical Laboratory of the Smithsonian Institution." It is an account of his experiments with the bolometer, begun on Mount Whitney in 1881 and continued for eighteen years, first at the Allegheny Observatory and, since 1890, at the Smithsonian Institution at Washington. The volume before us deals with this last period; the results of the earlier period are contained in the Report of the Mount Whitney Expedition, published as one of the professional papers of the U.S. Signal Service Department and elsewhere. Striking as these were, their interest and importance is entirely eclipsed by the new work.

Those who were fortunate enough to be at the Oxford meeting of the British Association in 1894 heard from Prof. Langley himself an account of his researches up to that date. The details on which that account was based are given in the new volume, together with the results of a completely new set of measurements, made in 1897-98.

Probably only the few who have used the bolometer can fully appreciate its difficulties. The principle of the research is simple. A spectrum is formed by suitable means and allowed to fall on the bolometer, a very narrow strip of blackened platinum placed parallel to the lines of the spectrum; this strip forms one of the arms of a Wheatstone's bridge, the other arms being a similar strip and two equal bridge coils. A screen is interposed between the spectrum and the bolometer, and the bridge adjusted until the galvanometer is undeflected. On removing the screen the bolometer strip is heated by that part of the spectrum which falls on it; its resistance is changed and, assuming the battery current to remain constant, the deflection of the galvanometer spot is a measure of the change of resistance of the strip and hence of the energy which it absorbs from the spectrum.

The spectrum is then made to pass slowly across the strip; by noting the corresponding deflections of the galvanometer, a map can be drawn showing the distribution of energy in the spectrum. In a region of a great energy the deflection is large, but as an absorption band crosses the strip it falls towards zero. When it is stated that a variation in the temperature of the strip of less than one millionth of a degree affects the galvanometer appreciably, some of the difficulties become apparent; the very slightest changes in temperature of any part of the electrical system produce effects in the galvanometer which mask the effects it is sought to observe.

In early days the observations were made by eye. The circle carrying the prism or grating which formed the spectrum was set and its position noted; then the screen was removed and the galvanometer deflection read. The circle was then moved and the operations repeated. In 1891-92 the apparatus was made autographic; the circle was turned uniformly by means of a clock, thus the spectrum crossed the bolometer strip at a uniform rate, while the spot of light from the bolometer mirror was focussed on to a sheet of photographic paper, which was made to move vertically at a rate bearing a fixed ratio to that of the circle. On developing the sheet a bolograph was formed, a curve in which the coordinate of any point measured parallel to the direction of motion of the sheet determines the portions of the spectrum to which the point corresponds, while the coordinate measured at right angles to the direction of motion gives the energy received by the strip from that portion of the spectrum. Peaks on the curve correspond to maxima of radiation, depressions to absorption bands or minima of radiation.

A very large number of these bolographs were taken, and the work contains numerous examples. The same general features recur in them, though of course there are small variations from day to day, some of which are real, depending on the weather, while others are accidental. A very full account is given of the steps taken to determine which of the depressions were real, *i.e.* actually due to absorption lines in the solar spectrum, and which were accidental, and of the method of measuring the twenty-one bolographs selected for final examination and record.

Full tables of the wave-lengths of the lines observed and of their relative intensities are given, and the whole is summed up in the normal map of the solar spectrum, which will be found at p. 200.

The general effect is shown in Plate xx., which gives the infra-red spectrum of a 60° rock-salt prism from the observations of 1898, showing both the bolographs, or energy curves, and the line spectrum. The bolographs are, it must be remembered, continuous curves having peaks and depressions; the method adopted for obtaining photographically from these a diagram of a line spectrum as usually drawn is explained on p. 73 thus:—

"One method of obtaining a linear spectrum consists in blacking in all of the plate below the photographic plate and then photographing this through a combination of a spherical and cylindrical lens, which draws the blacked-in portion out into regions of greater or lesser shade according to the linear depth of the blacked-in portion."

". . . In the original curve the greatest elevations represent regions of the greatest heat, the greatest depressions regions of the greatest cold; and if we fix our attention on these great regions only, they can be adequately rendered into bright and dark bands respectively, but the detail is comparatively ill rendered without a special adjustment, which would in turn give a false presentation of the great masses of light and shade."

This treatment, illustrated by figures in the book, consists of blacking out the whole of the under side of the curve and most of the upper side, but leaving as a transparent spot a small area at the vertex of each marked depression, the size and shape of the area depending on

[1] "Annals of the Astrophysical Observatory of the Smithsonian Institution." Vol. i. By S. P. Langley, Director.

the form of the curve. When this plate is photographed, a series of dark lines, the intensity of which depends on the size and shape of the corresponding transparent areas, is produced. By superposing this photograph on the former one which gave the general distribution of light and shadow, a representation of the linear spectrum of the bolograph is obtained. Clearly, considerable skill and judgment are required in such a process, and the linear spectra are only introduced to show the general effect and to enable the reader to compare the infra-red with the visible spectrum; the measurements of the position of the lines are all made on the selected bolographs themselves.

Chapter vii. contains an interesting account of the variations of absorption in the infra-red spectrum, which is shown to be the seat of great terrestrial atmospheric absorption, the relative intensities of energy changing greatly at different periods of the year in some portions of the spectrum, while in others they remain fairly constant in amount.

But little space is left to refer to Part ii., subsidiary researches, which to a student of theoretical optics may prove even more interesting than the main research. The first of these deals with the dispersion of rock salt and fluorite. It is sufficient, perhaps, to say that the dispersion curve for rock salt is drawn from wave-length $0{\cdot}5\ \mu$ to $6{\cdot}5\ \mu$, and the results compared with a formula —Ketteler's formula,

$$n^2 = a^2 + \frac{M_2}{\lambda^2 - \lambda_2^2} - \frac{M_1}{\lambda_1^2 - \lambda^2},$$

where

$$a^2 = 5{\cdot}174714$$
$$M_2 = 0{\cdot}0183744$$
$$\lambda_2^2 = 0{\cdot}015841$$
$$M_1 = 8949{\cdot}520$$
$$\lambda_1^2 = 3145{\cdot}695.$$

This formula agrees admirably over the whole range.

Another appendix gives a full account of the construction of the galvanometer used for the research. In this instrument, various sizes of wire were used in the different sections of the coil; its resistance was 28 ohms, and the external radii of the three sections of which each coil is composed are respectively ·383, ·741 and 1·632 cm.

Two magnet systems were tried, the one being 2·4 mgs. in weight, the other 6·5 mgs. With the former, which proved too light for the work, a deflection of one millimetre at a distance of one metre was given by a current of 5×10^{-12} ampere; with the latter the current required was 23×10^{-12} ampere.

Enough, perhaps, has been written to indicate the interest and importance of the work. Prof. Langley is to be congratulated in having brought it to so successful a conclusion.

R. T. G.

SOUTH AMERICA.[1]

IN the volume under notice, Mr. A. H. Keane gives a much needed compendium of the geography of South America. Since its independence from Spain and Portugal, that half-continent has been making great commercial strides, until its trade now equals in value that of British India. The importance of its varied products, its peculiar ethnological history, its wonderful physical features, its modern political advancement, make it a region of constantly increasing interest to the merchant, the man of science, the student and the statesman; while the fact that only about five-sevenths of it have thus far been explored and partially mapped makes it a favourite field for the geographer. Mr. Keane appears to have understood exactly what the world in general required from his able pen, and instead of confining himself to geography pure and simple, as the title of his work indicates, he has taken his subject in its most comprehensive sense. He gives us, in three preliminary chapters, the physical features of the country, its orography, great plains, plateaux, fluvial systems, seaboard, fjords, outlying islands, climate, flora and fauna and a valuable dissertation upon the ethical and later ethnical and historical relations of its much scattered tribes. He holds it to be "beyond reasonable doubt that man had spread in early Pleistocene times from his eastern cradle to the New World, probably by two routes —from Europe by the still persisting land connection with Greenland and Labrador, and, from Asia, by the narrow Bering Strait." He bases this assertion upon the fossil remains of man which are found in North and South America, "representing the two primordial types, which may be called the long-headed Afro-European and the round-headed Asiatic. These, strange to say, are found in far greater abundance in the southern than in the northern division." . . . "The inference seems inevitable that South America was already in Pleistocene times peopled to its utmost limits by two primitive races that still persist in the same region"—a statement which admits of doubt. "The long-heads are believed to have been the first arrivals . . . and later the round-heads," the latter "generally keeping to the Pacific side." The former are supposed to have afterwards migrated from their early settlements in southern Brazil and Argentina over a greater part of eastern South America.

There is no more delightful and vexatious field for anthropological and ethnological research than South America. The physical alterations which it has undergone, even in very recent geological periods, the separation of its eastern from its western portion by immense inland seas, the vast denudation of the orographic system of the Brazilian and the recent uplifting of the Andean section, the formation of its wonderful rivers, all probably largely effected since the occupation of the continent by man, have woven many factors into the problem of racial development there. The few traces which forgotten peoples have left under extraordinary physical changes and climatic influences, and the fragmentary knowledge existing regarding South American tribes, make it appear venturesome to indicate the routes by which their progenitors first penetrated the southern half of the New World. The problem seems to require more study than it has yet received before its solution can be safely approached. But the somewhat extensive remarks of Mr. Keane upon South American ethnology are very valuable—doubly so from the fact that he not only summarises his views in his "General Survey," but elaborates them as he afterwards passes each country in review, thus making his work of great importance to the student of tribal origin and development on the western continent. Mr. Keane justly comments on the purity of race in the United States in comparison with Latin America, "where all the ethnical elements have, from the first, tended to be merged in a fresh division of mankind, which may eventually acquire a uniform character, but must long continue to betray its diverse origins in the heterogeneous nature of its physical and mental qualities." And yet it is not entirely improbable that in several of the Spanish American States, notably Mexico and Bolivia, the mentally and physically strong native race are reasserting themselves, and absorbing, thinning-down and gradually dissipating the blood of their conquerors.

The description of each State includes its boundaries, so far as they are claimed or defined, its physical features, hydrography, climate, flora, fauna, inhabitants, wild tribes, topography, chief towns, period of discovery, conquest, settlement, colonial rule, religion, education, natural resources, mineral and agricultural productions and a

[1] "Stanford's Compendium of Geography and Travel (new issue) Central and South America." Vol. i. By A. H. Keane. Edited by Sir Clements Markham, K.C.B., F.R.S. Pp. xxii + 611. (London: E. Stanford.) Price 15s.

historical outline, thus giving us, *á grandes rasgos*, the *data* sought by any one who desires, in a limited space, to acquire a general knowledge of the country.

Regarding Venezuela, "it is still mainly inhabited by scattered rural communities and nomad tribes, with scarcely any large industrial or commercial centres." As to the Orinoco River system, "these magnificent inland waters are at present utilised in a regular way only by a single steamer, plying once a fortnight between Trinidad and Ciudad Bolivar," which is the only town of any importance on the Orinoco. To this river Mr. Keane gives a fall of about nine inches to the mile in a distance of 1300 miles, counting from the Cassiquiare Canal, that remarkable connecting link between the waters of the Orinoco and the Amazon. It is doubtful if the average slope is more than three inches to the mile, the mistake arising from the elevation of 920 feet above sea-level, which Mr. Keane assigns to the Cassiquiare, which probably does not exceed 335 feet elevation. This is one of the most important elevations in the interior of South America, and, since remote times, it has largely governed its hydrographic conditions. There is no part of the world where there is greater confusion in altitudes and distances, and the writer on the geographical features of South America often finds his patience sadly taxed by the disagreement between travellers and explorers regarding measurements.

The States of Colombia and Ecuador form interesting chapters of the work under consideration. The former, which is just terminating a most bloody and disastrous politico-religious war, aggravated by the influx of a swarm of Philippine friars, is a land where nature seems to have overlooked no favours within her power to bestow, and Mr. Keane pictures them with graphic pen. As to Ecuador, the most dormant of all the South American States, he says :—"The backward state of the agricultural interests is no doubt partly due to the constant political ferment which drives off capital, but also in great measure to the feudal system of land tenure. The whole country belongs to a few absentee owners, whose estates are often of boundless extent." He is right in part, but the religious institutions should have been included among the proprietors of the country *and its people*. It would also have been well to add that the interior of Ecuador, since the Spanish conquest, has had contact with the outer world by only two mule-tracks, both intransitable during the rainy season, and that, behind the coast cordillera, the priest has, for more than three centuries, had undisturbed opportunity to try his theories of progress. The result has been disastrous to the morals and advancement of the people, who are sunk in intellectual and physical degradation.

Peru, Bolivia, Chile, the Argentine Republic, Paraguay and Uruguay are treated according to their relative importance ; but sometimes the reader craves greater detail upon many interesting points, probably unwillingly withheld and retained in the abundant stores of information apparently in possession of the author.

In general, the maps which accompany the work are unworthy of the text ; old geographical errors are reproduced, and the maps are in no sense up to date, except those of Chile and the Argentine Republic, *which are more than up to date* ; for the question of limits between these countries, which is now under arbitration by the English Government, is apparently decided entirely in favour of Chile, although upon what grounds does not appear, as Mr. Keane and the editor, Sir Clements Markham, have wisely avoided any expression of opinion on the subject. One must therefore attribute to the publisher the glaring inconsistencies between *his* maps and the text of the work, it being evident that the author is not responsible for them. The boundary, as laid down between Chile and Argentina, is only of value in one sense—it shows the extent to which Chile hopes the English umpires will allow her to push her claims. The line could not have been better traced by the Chilian Foreign Office. To Chile alone it is useful ; but the public expect that a map publisher of

Lake Nahuel-huapi, in the Andes of north-western Patagonia.

repute will hold an even balance where boundaries are *sub judice.*

In the case of the Chile-Bolivia boundary, it appears that the publisher also considers that Bolivia has no territorial rights which Chile is bound to respect.

Mr. Keane closes his work with an extensive and valuable chapter on Brazil, a country which occupies nearly one-half of the area of South America. His remarks upon the "ethnical elements of the population and their distribution" he considers of value in estimating the probable political future of the Republic. "The triple fusion of aborigines, negroes and Europeans is mainly confined to the Atlantic States between the Amazon estuary and Rio de Janeiro. Then follow the States of San Paulo, Paraná, Santa Catharina and Rio Grande do Sul, with which must be grouped the vast and relatively populous region of Minas Geraes. Here we have no triple fusion, the negro element being everywhere mainly absent; but, as in Spanish America, an amalgam of aborigines and whites . . . which constitute the second section of the Brazilian people, distinguished from the first by the absence of black blood. Lastly, the aboriginal element tends to disappear in the direction of the south, where the white element is continually strengthened by direct accessions from various parts of Europe, but especially Italy, Portugal and Austria."

As to the above quotation, the State of Minas Geraes is the most populous in Brazil, and the negro element is everywhere in evidence; and instead of an "amalgam of aborigines and whites," few of the inhabitants are free from negro blood. Exclusive of the aboriginal tribes, one seldom finds any traces of Indian blood among the Brazilians except in the immediate vicinity of the banks of the main River Amazon.

Notwithstanding a few details where we might disagree with Mr. Keane, he has given us a most useful work of reference; but every reader at all familiar with South American geography will regret that the maps are not more trustworthy. GEORGE EARL CHURCH.

ZONES IN THE CHALK.

ATTENTION was directed in NATURE for April 26, 1900, to Dr. A. W. Rowe's researches on the zones of the White Chalk of Kent and Sussex. Dr. Rowe has since published his observations on the White Chalk of Dorset (*Proc. Geol. Assoc.*, vol. xvii. part i. 1901). Aided in the field as before by Mr. C. Davies Sherborn, the author has made a particular study of the higher portions of the Chalk which commence with the zone of *Rhynchonella Cuvieri.*

Those who are familiar with this portion of the Dorset coast, or have read Mr. Aubrey Strahan's explanatory memoir (published by the Geological Survey), know how faulted and crushed are the strata in many places, and how difficult or impossible of access are many portions of the cliffs. Undaunted, however, by these obstacles, or by the hardness of the Chalk and the trouble in extracting and preserving the often shattered fossils, Dr. Rowe and Mr. Sherborn "have been able to fix, with varying degrees of accuracy, the limits of nearly every zone," and to record from each a characteristic fauna. While confirming the general conclusions of Dr. Barrois, they have amplified our knowledge to a remarkable extent, and have had the satisfaction of determining the presence, hitherto unsuspected in the region between White Nothe and Studland Bay, of the higher Chalk zones of *Actinocamax quadratus* and *Belemnitella mucronata.*

That zones in the Chalk are purely zoological divisions is thoroughly borne out in this paper, and although it is remarked that "nothing but rigid collecting gives one the faintest chance of obtaining the junction between the various beds," it is evident that no more definite boundary is to be expected between zones than that which in human chronology separates one century from another. Here and there particular flint-bands, the nodular character or the colouring of the Chalk afford local guides for marking approximate junctions or for tracing horizons from place to place amid the complex disturbances of the strata; and these have been carefully noted. Dr. Rowe, indeed, felt some "anxiety to find a lithological feature" whereby to permanently mark the planes of division he took, but this was seldom possible, nor could it reasonably be expected in such a comparatively uniform series of strata. Nevertheless, the results of Dr. Rowe's painstaking work have been in many instances permanently recorded in a series of beautifully executed plates prepared from photographs taken by Prof. H. E. Armstrong. Diagrams accompany these plates to show the positions of the several zones and the limits assigned to them. No higher testimony to the value of zones has, perhaps, ever been given in this country, for the authors have had a veritable geological puzzle to deal with, and they have interpreted it by means of their long experience of Chalk fossils and by assiduous collecting. By these means the knowledge elsewhere gained where the sequence is unbroken has been applied with marked success, and the progressive changes in the life-history of the Chalk have been found to correspond with a precision that could not have been expected in strata deposited under more varying conditions. While the zones are marked out within narrow limits by certain dominant species, yet where these zonal forms are absent the "zones are often as accurately defined by their associated guide-fossils." These are noted with reference to Dorset.

It may be observed that, with the exception of *Marsupites*, *Actinocamax quadratus* and *Belemnitella mucronata*, the dominant forms are not confined to the zones they characterise. The author makes some remarks on the varying position of the layers described as Chalk Rock. No doubt any type of rock may be found at any horizon, but it must be remembered that the limits assigned to Chalk zones are approximate. There is nowhere any real boundary, and even some dominant types may have existed in abundance longer in some areas than in others. H. B. W.

THE ORIGIN AND HABITS OF THE BACTRIAN CAMEL.

OF few of our larger domesticated animals is the origin so buried in mystery as is that of the camels. Till a few years ago, indeed, naturalists were in doubt whether the two-humped Bactrian species was really a native of the countries where it is now kept in a domesticated condition. The probability was, however, all in favour of such being the case; and the recent discovery of remains of fossil camels in several parts of Europe, as well as the occurrence of such remains in Asia, afford strong corroborative evidence that eastern Europe and northern Asia formed the original habitat of the wild Bactrian species.

The subject has recently been discussed in *Globus* for May 2, 1901, by Dr. A. Nehring, of Berlin, who expresses himself in favour of the view that some, at least, of the two-humped camels which roam at liberty over the wastes of the Gobi are indigenously wild animals.

Years ago the occurrence of remains of fossil camels (*Camelus sivalensis*) was recorded by Falconer and Cautley in the Tertiary strata of the Siwalik Hills of northern India. The dentition of this species is numerically the same as in the two living members of the group; and from this circumstance, coupled with the well-known affinity between the extinct fauna of the Siwaliks and that of Africa at the present day, it is not improbable that the Siwalik camel was the ancestor of the single-humped African species, since, as will be shown below, there is a probability that the ancestor of the Bactrian species had a fuller dental series.

And here it may be well to mention that in adult modern camels there are normally five pairs of cheek-teeth in the lower jaw behind the tusks, or canines. The first pair (the first premolars) are, indeed, somewhat like a canine in form, and are separated by a gap from the canine in front and from the remaining four of the cheek-teeth behind. Of the latter, the last three pairs are the true molars, while the tooth in front of them represents the last of the typical series of four premolars.

Now in the lower jaw of a fossil camel recently described from the Pleistocene Tertiary strata of Rumania, by Herr Stefanescu, under the name of *Camelus alutensis*, there are six, in place of five, pairs of lower cheek-teeth, the tooth representing the third lower premolar being developed. Evidently we have here an ancestral type of camel, and it is noteworthy that, according to Dr. Nehring, this supernumerary lower tooth occasionally makes its appearance in living camels, although it is not mentioned in which species. The remains of the Rumanian camel were discovered on the left bank of the Aluta (Olt) river, a tributary of the Danube, not far from Slatina.

Evidently, remarks Dr. Nehring, this Rumanian camel was a member of the steppe-fauna, of whose former existence in central Europe evidence is afforded by the occurrence of fossil remains of the saiga, Kirghiz jerboa and other species now characteristic of the Volga steppes. Another fossil camel has also been described, under the name of *Camelus knoblochi* or *C. volgensis*, from strata in the neighbourhood of Sarepta, on the Volga, and also at the mouth of the Tscheremschan, in the Government of Samara, the number of lower teeth in this species being apparently the same as in modern camels.

As members of the steppe fauna, these Rumanian and Russian fossil camels were almost certainly the ancestors of the living Siberian species; and since the Rumanian species has a larger number of lower teeth than the still older Siwalik camel, it is manifest that the latter cannot have been the progenitor of the Bactrian species. Hence the reason for regarding it as the ancestor of the single-humped camel of Africa. The Russian camel-remains, it may be added, were found in association with molars of the mammoth.

Remains of camels have also been found in the Pleistocene strata of Oran and Ouen Seguen, in Algeria; and certain remains from the Isle of Samos have recently been assigned to the same genus, although the reference requires confirmation. The Algerian Pleistocene camel was doubtless the direct ancestor of the living African species, which it serves to connect with the extinct *C. sivalensis*.

With regard to the camels of the Gobi, which, as already mentioned, Dr. Nehring regards as truly wild, it is interesting to note that some years ago Dr. Langkavel described them as being much smaller than the domesticated breed, not, indeed, much superior in size to a horse with relatively slender limbs. Observations in confirmation of this statement are, however, urgently required; and any travellers who may visit the Gobi neighbourhood would do service to science if they would bring back skins and skeletons of the wild camels.

Nothing is more remarkable in connection with the Bactrian camel than its capacity for standing extremes of heat and cold, provided always that the climate be dry. Herr O. Lehmann (*Zeitschr. wiss. Geographie*, 1891, p. 27), for example, writes as follows:—

"The most severe winter cold of Asia cannot prevent the presence of the camel. In west Siberia, from the Kirghiz steppe to the neighbourhood of Lake Baikal, are camels found. . . . In Semipalatinsk the mean winter temperature falls to $-21^{\circ}\cdot9$ C.; the most intense registered between the years 1854 and 1860 was $-49^{\circ}\cdot9$. During his journey Przewalski experienced the most intense cold without losing a single camel. Throughout his whole journey across the Mongolian plateau he daily encountered a temperature of -37°. . . . Again, in Zaidam, where camel-breeding establishments exist, a night temperature of $-23^{\circ}\cdot6$ was observed, which in November was intensified to $-25^{\circ}\cdot2$. In the neighbourhood of Tarai-nor, on the 50th parallel of north latitude, the Burjæts keep numerous camels, which even in winter are allowed to wander about without the slightest protection. . . . Here the camel reaches the 50th parallel, westward of Lake Baikal, on the Upper Yenisei, where the Samoyeds keep both reindeer and camels. Here, indeed, the breeding-area of the camel overlaps that of the reindeer."

In regard to its capacity for heat, the same author records the following observations:—"If the degree of cold that the Bactrian camel can withstand is wonderful, not less remarkable is the heat it can undergo. In the Gobi Desert Przewalski took the temperature of the ground in summer and found it to be $62^{\circ}\cdot5$ C." R. L.

NOTES.

We regret to see the announcement of the death of Prof. W. Schur, professor of astronomy in the University of Göttingen.

The Antarctic exploration ship *Discovery* was inspected by the King and Queen at Cowes on Monday. Their Majesties were received by Sir Clements Markham, K.C.B., who presented Commander Scott, who in turn presented the officers of the ship and the scientific staff. The King showed great interest in the laboratories and the instruments for scientific work, which were explained by Mr. George Murray, F.R.S., who accompanies the ship to Melbourne, and Dr. H. R. Mill, who will go as far as Madeira in order to start the oceanographical observations on the way out. The ship left Cowes on Tuesday, with hearty wishes for a voyage free from calamity and fruitful in scientific results.

We understand from the *Irish Naturalist* that Prof. A. C. Haddon, F.R.S., intends to resign the chair of zoology at the Royal College of Science, Ireland, which he has occupied since 1880, in order to devote more time to anthropological work.

The death is announced, at San Francisco, of Dr. H. W. Harkness, known for his contributions to entomology and botany. For several years Dr. Harkness was president of the California Academy of Sciences, to which institution he presented his large collections of specimens of cryptogams.

The *Express* states that Profs. Haeckel, Conrad and Fraas, of Jena, Halle and Stuttgart Universities respectively, announce that the sum of 1500*l*. has been placed at their disposal as a prize for the best work on the question, "What do we learn from the principles of the theory of heredity in reference to the inner political development and legislation of States?" Manuscripts must be in German and sent not later than December 1, 1902, to Prof. E. Haeckel, Jena.

According to a *Times* correspondent, Dr. Berson and Dr. Suering, who made a balloon ascent from Berlin on July 31 and descended near Kottbus in the morning of the following day, succeeded in reaching an altitude of more than 10,300 metres. It was impossible to ascertain the greatest altitude attained, as both the aëronauts lost consciousness in consequence of the rarity of the air. The minimum temperature registered was -40° C.

We learn from *Science* that, aided by a special fund presented by a friend of the American Museum, Prof. Osborn recently sent out two expeditions especially in search of fossil horses—

one to Texas and one to eastern Colorado. Word has just been received at the Museum that the very first discovery made by the Texas party included a deposit of skulls of the three-toed horse, Protohippus, associated with parts of the limbs, feet and backbone. This is one of the stages especially desired in the long series leading up to the modern horse. The skulls are reported to be the best that have thus far been found, and this discovery is an auspicious opening to this special series of explorations.

THE fifth annual Fungus Foray of the British Mycological Society will be held at Exeter from Monday to Saturday, September 23–28. The club dinner will be held on September 24, after which the president, Prof. H. Marshall Ward, F.R.S., will deliver his presidential address. On September 25, Miss A. Lorrain Smith will read a paper on "The Fungi of Germinating Farm Seeds," and on the following day a paper on "Spore Formation in Yeasts" will be read by Mr. Barker.

IT has been found that one of the most effective methods for destroying locusts in humid climates is by propagating among them the well-known fungus disease. The Cape of Good Hope fungus, described by Dr. Sinclair Black, is the *Empusa acridii*. To employ it, a culture is prepared on moist bread crumbs and scattered in places frequented by the locusts. The locusts which consume the bread die, and their bodies are eaten by other locusts and thus the disease spreads. The method is less effective in dry weather.

MR. C. A. BENBOW, writing in the *Agricultural Gazette of New South Wales*, strongly recommends the introduction of the eland of Cape Colony into the scrub lands of New South Wales and Central Australia. This scrub land is almost valueless as pasture, especially in years of drought. The eland is, however, accustomed to feed on the same leguminous shrubs in South Africa which form the scrub of Australian lands. The animal is one of the largest of the antelopes, often equalling an ox in weight, is easily domesticated and produces meat of exceptionally fine quality.

IN the *Bulletin* of the American Geographical Society (No. 3, 1901), Mr. R. de C. Ward gives a note on the climate of Mammoth Tank, situated in the southern portion of the Colorado Desert, and one of the most interesting places in the United States from a meteorological point of view. The mean temperature of July is 98°·5, and of January 53°·9. The highest temperature recorded was 130°, in August, 1878, and the lowest 22°, in December, 1895, giving an absolute range of 108°; temperatures of 100° and over have been recorded in every month of the year except the four winter months, November to February. The mean annual rainfall for twenty-three years is 1·81 inches; the greatest amount in any one year was 5·48 inches, while in the two years 1897 and 1898 there was only a trace.

AN interesting paper was recently submitted to the Royal Academy of Belgium, by Dr. E. Vanderlinden, on the atmospheric conditions that accompany fog in that country. The inquiry is based upon an examination of some 200 synoptic charts, the winter and autumn fogs being studied separately from those which occur in summer. The author shows that the winter fogs are mostly connected with anticyclonic conditions, while those of summer occur during periods of shallow or secondary barometric depressions. The winter fogs rarely occur on the western side of an area of high barometric pressure. In reporting to the Academy upon the paper, M. Lancaster points out that most authors who treat of the question of the formation of fog only deal with very local areas, in which temperature plays the principal part, but that this kind of fog should not be confounded with the general phenomenon characteristic of winter fogs, which depend upon the barometric pressure. The most favourable conditions for fog formation are damp air and a temperature a little above freezing point. These conditions generally occur in winter with westerly winds and when the centre of the high-pressure area lies to the south-east of the point of observation, but M. Lancaster points out that the action of temperature alone is not sufficient to explain completely the occurrence of certain types of fog.

SINCE the article upon the recent work of the United States Weather Bureau appeared in NATURE of May 23 (p. 80), the Report of the Chief of the Bureau on the operations during the year ending June 30, 1900, has been received. In addition to the usual tables containing the results of observations made at Weather Bureau stations in the United States, Mr. E. B. Baldwin gives a detailed account of the meteorological observations made by him in Franz-Josef Land during the second Wellman expedition in 1898–1899. The lowest temperature experienced seems to have been recorded on February 1, 1899, when a minimum of forty-five degrees below zero Fahrenheit was observed. The means of the maximum and minimum temperatures recorded by the thermograph in the first three months of the year 1899 are as follows, in degrees Fahrenheit:—January, max. −10°·9, min. −24°·0; February, max. −5°·4, min. −19°·4; March, max. 16°·7, min. −26°·8. A very complete record of auroral phenomena was kept by Mr. Baldwin, and has been published in the U.S. *Monthly Weather Review* for March, 1901.

THE representation of electromagnetic phenomena by mechanical models was brought into prominence many years ago by Maxwell's well-known model of a dicyclic system representing the mutual induction of two currents. Prof. Garbasso now sends us a number of papers dealing with the construction of mechanical models representing the discharge of condensers, in particular in the case when the armatures of a condenser are connected by two wires in parallel. The most recent of his papers, dealing with the maximum value of the electrokinetic energy of mutual induction of two currents and its physical interpretation, appears in the *Nuovo Cimento* for June (5, i.)

A NOTE on some discontinuous and indeterminate functions by Mr. Charles Kasson Wead in the *Bulletin* of the Philosophical Society of Washington is rather suggestive. The treatment is based on the fact that if $u = (x/a)^\infty$, $u = 0$ or ∞, according as $x <$ or $> a$, so that if N is any positive number greater than unity, $N^{-u} = 0$ or 1 according as $x >$ or $< a$. By means of this factor the author shows how it is possible to construct equations representing broken lines or portions of plane areas within or without given plane curves. As physical applications, the author shows how to represent by a single expression the potential of a solid sphere, or the attraction of a spherical shell at points both inside and outside the sphere.

WE have received several papers by Prof. Sommerfeld, dealing with the theory of the diffraction of Röntgen rays. One of these is published in the *Zeitschrift für Mathematik und Physik*, xlvi. 1, 2, and abstracts are also given in the *Physikalische Zeitschrift*, ii. The special problem which forms the subject of Prof. Sommerfeld's work is the mathematical investigation of the results of the hypothesis put forward by Wiechert and Stokes, according to which Röntgen rays consist in an impulsive disturbance propagated through the ether. The author considers the problem of diffraction past a screen in the form of a half-plane and allied problems, and compares his results with those found by Haga and Wind and others. The single non-periodic impulse may be said to represent one extreme case of ray-propagation, while the purely periodic wave represents the other extreme. While actual Röntgen rays and light-rays probably only approximate to these extreme cases, the agreement between Prof. Sommerfeld's conclusions and experimental results affords considerable evidence in favour of the above theory of Röntgen rays.

IN the *Johns Hopkins University Circular*, No. 152 (vo . xx. pp. 79–80), Mr. C. C. Schenck gives a short description of a series of investigations undertaken with the twofold object of (1) separating the principal lines in the spark spectrum of cadmium into three groups having characteristic properties, (2) studying the constitution of the various regions of the spark and its spectrum by means of a revolving mirror. It was found that a preliminary division of the spectrum lines into groups was feasible by noting the changes produced in the spark spectrum when the period of the condenser in the secondary circuit was varied by increasing the self-induction. Kirchhoff in 1861, and Thalen in 1866, stated the effect in general terms, and Hemsalech has recently carried the investigation much further. The spark was produced by an induction coil supplied with alternating current; secondary condenser about ·016 microfarad, spark length 6–8 mm. The spectrum was photographed with a large concave grating of 21 feet radius. The three groups of lines described appear to correspond to the well-known "long" and "short" lines always seen when an image of a light source is thrown on the spectroscope slit, but no wave-lengths are given for comparison. It is stated, however, from an examination of the conditions giving rise to the three groups of lines, that the average temperature of the metallic vapours in the arc is probably *higher* in some cases than in the spark. The experiments with the rotating mirror indicated that the chief arc lines had a duration more than twice as great as that of the chief spark lines. Also that the principal spark lines (both of cadmium and magnesium) are due almost entirely to the curved streamers seen branching from the spark, while the chief arc lines are due in part to the streamers and in part to a luminosity which fills up the spark gap and persists after the streamers cease.

THE "Birds of Western New York" is the title of an article by Mr. E. H. Eaton which appears in vol. iv. of the *Proceedings* of the Rochester (N.Y.) Academy of Science. Although at first sight this may appear nothing more than an ordinary local fauna-list, it is really worth the best attention of every naturalist on account of the elaborate manner in which the subject is treated. Specially noteworthy are the diagrammatic "migration and residence tables," in which it is attempted to show graphically "the times of occurrence and relative abundance of the birds definitely recorded for this region." The essay is, in fact, an admirable example of the way in which local faunas should be recorded and described.

THE most noticeable feature in the Report of the American Museum of Natural History for 1900 is the number of expeditions which have been undertaken with the view of adding to the ethnological and palæontological collections. Although the majority of these were confined to North America, one—the Jesup North Pacific Expedition—was despatched to the Amur valley, while two were sent to South America. The former, it is reported, has brought back a valuable series of specimens illustrating the ethnology and anthropology of the Ainu of Japan; while of the two latter, the mission to Patagonia has acquired a valuable collection of the extinct mammalian fauna of that country. But the amount of strictly scientific work accomplished has not hindered attention being paid to the educational function of the Museum; and the president, in his report, calls special attention to the opening of the new and spacious "auditorium," where secondary education is to be offered to the public in the form of popular lectures.

DR. B. HAGEN gives in *Globus* (Bd. lxxix. p. 245) a beautifully illustrated account of his ascent of Kaba, in Sumatra, which is 1650 metres in height. This volcano has previously been ascended by A. W. P. Verkerk, R. D. M. Verbeek and H. O. Forbes.

THE Berlin Museum für Völkerkunde has recently been enriched by the addition of a number of wooden human effigies from German New Guinea, some of which are described and figured in *Globus* (Bd. lxxix. No. 22, p. 352) by D. Rudolf Pöch. The head appears to be hidden in most of them by a mask, which has a long beak which looks more like a snout than a bird's beak; but from the carving above its insertion there can be little doubt that the bird that is represented is the hornbill, which is a magical or symbolic bird all over the Malay region and throughout the greater part of New Guinea as well. On the top of the mask a figurine of a cuscus is often carved. We still await an explanation of these remarkable objects.

THERE is an interesting little paper by M. Félix Regnault, illustrated by numerous figures, in the *Bulletin de la Société d'Anthropologie de Paris*, 1900, No. 6, on Greek terra-cottas from Smyrna. In the hundreds of specimens in the Museum in the Louvre there are many beautiful ones after the manner of the famous figurines from Tanagra and Myrina; some are grotesque, others are ethnic types, anatomical studies and even illustrations of pathological conditions. It is with the latter that the present paper deals. Various examples of facial deformations are given, such as facial paralysis and adenoid growths. Pronounced acrocephaly and scaphocephaly, as well as illustrations of idiots and degenerates, were moulded by these observant potters. The other articles in this journal are mainly of interest to professional anthropologists.

IN his "Laboratory Outlines for use in an Introductory Course in Somatology" (*American Anthropologist*, n.s. vol. iii. p. 28), Mr. Frank Russell has hit on a very useful idea, which, however, is susceptible of improvement. For example, no indication is given of the system of head-form nomenclature introduced by Sergi; the system of the Italian anthropologist, as a whole, may be cumbersome and difficult to grasp, but his primary forms are readily recognisable and are of distinct classificatory value. Like the majority of anthropologists, Mr. Russell omits the valuable series of radial measurements that are taken from the ext. aud. meatus and which can be compared with similar measurements made on the living. The prosopic, &c., measurements should be placed in the nasal and not in the orbital category. If Mr. Russell were to reconsider his schedule in some details and were to state where the terms, measurements and indices were described in readily accessible publications, or, better still, were to republish this information, he would produce a pamphlet which would be of very great use to students of physical anthropology.

MR. JAMES STIRLING, Government geologist of Victoria, has prepared a report on the brown coal industry in Germany and Austria, which has been issued by the Department of Mines, Victoria, through the Agent-General in London (1901). The main object is to promote a similar development of brown coal production in Victoria, where such fuel would be of service on branch railway lines and for goods traffic where a slow rate of speed is maintained.

FROM Indiana we have received the twenty-fifth annual report for the Department of Geology and Natural Resources of the State geologist, Mr. W. S. Blatchley. A large part of this report is taken up with particulars about marls and limestones and the manufacture of cement; the petroleum industry is also dealt with, and Mr. Blatchley describes two new species of salamanders from Tennessee. In addition, there is a monograph on the Devonian fossils and stratigraphy of Indiana, by Mr. Edward M. Kindle. The fossils are illustrated in thirty-one plates, and some new species of Mollusca and Brachiopoda are described.

THE Eocene deposits of Maryland are elaborately described and illustrated by Prof. W. B. Clark and Mr. G. C. Martin in one of the handsome volumes issued by the Maryland Geological

Survey (1901). Materials do not exist for a detailed correlation of the strata with those in Europe, as the few identical species have a wide range in time, but there is little doubt that the Maryland deposits represent a considerable portion of the Eocene series. In the palæontological section the authors personally deal with the Echinodermata, Brachiopoda and Mollusca, and have been aided by specialists in other groups. The work is illustrated by pictorial views, maps and sections, and numerous figures of fossils.

WE have received the general report of the Director, Mr. C. L. Griesbach, on the work of the Geological Survey of India for the year ending March 31, 1901. Eight officers have been occupied in field-work. Among the regions examined are the Shan States in Burma, where great difficulties had to be encountered in the extensive forests and dense undergrowths, while frequently the actual rock is covered by a soil-cap fifty or more feet in thickness. Evidence has, however, been obtained of older crystalline rocks and of Lower Silurian or Ordovician, while the occurrence of Devonian, which had been inferred by Mr. P. N. Datta, has been confirmed by Mr. La Touche, who found *Calceola sandalina*. The presence of Triassic rocks was first recognised by Mr. Datta. In Assam, Tertiary, Cretaceous and older strata have been mapped by Mr. P. N. Bose; in Himalayan regions, Dr. A. von Krafft has been at work on Triassic rocks; and in Baluchistan Mr. E. Vredenburg has examined the complicated structure of the Chapar range, where numerous folds and overthrusts occur among Cretaceous and Tertiary strata. The subject of landslips has been locally dealt with by Mr. T. H. Holland, and special attention has been given to gold-bearing regions and to water-supply. In palæontology, aid has been received from Dr. F. L. Kitchin in England, Prof. Dr. Uhlig in Austria and Prof. R. Zeiller in France.

ONE of the recent publications of the Geological Survey of Egypt is devoted to a description of Farafra Oasis, by Mr. Hugh J. L. Beadnell. This wide depression, the "Land of Cattle" of the ancient Egyptians, lies in the Libyan Desert far west of Assiut, one of the most important towns of Upper Egypt. Although occupying a large area, the oasis appears to be of little importance from an economic point of view, being, in fact, a stretch of low desert with about twenty isolated "bubbling springs" (Farafra), most of them on the western side. The water is entirely derived from white, chalky limestone of Upper Cretaceous age, which, as observed by Prof. Zittel, forms the plain and is overlaid by Lower Eocene beds, the strata being bent into a gentle anticline. The depression has an irregular triangular shape with the apex to the north and is bounded by steep cliffs of Eocene strata on the east and west, while to the south the floor rises gradually for many miles until a distant escarpment is reached. A large part of the floor is covered with blown sand, and the action of this drifting material has eroded the chalk and left on the surface of the plain numerous fragments and masses of iron pyrites and marcasite derived from that formation. The author differs from Zittel in believing that there is a considerable break between the Cretaceous and Eocene strata. The former rocks are grouped as belonging to the Danian division, but the fossils have yet to be critically examined.

THE additions to the Zoological Society's Gardens during the past week include two Indian Wolves (*Canis pallipes*) from India, presented respectively by Colonel Lloyd and Mr. W. B. Cotton; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Miss E. M. Berney; a Demoiselle Crane (*Anthropoides virgo*), a Lesser Black-backed Gull (*Larus fuscus*) from North Africa, presented by Dixon Bey; a Puffin (*Fratercula arctica*), British, presented by Mr. H. C. Price; a Cinereous Vulture (*Vultur monachus*), three Indian Rat Snakes (*Zamenis mucosa*) from India, presented by H.E. Sir H. A. Blake, G.C.M.G.; two American Jabirus (*Mycteria americana*) from South America, presented by H.E. Sir W. J. Sendall, G.C.M.G.; three Chameleons (*Chamaeleon vulgaris*) from North Africa, presented by Mr. A. Robinson; a Patas Monkey (*Cercopithecus patas*), a Green Monkey (*Cercopithecus callitrichus*), a Campbell's Monkey (*Cercopithecus campbelli*), a Bell's Cinixys (*Cinixys belliana*), an Eroded Cinixys (*Cinixys erosa*) from West Africa, a Pinche Monkey (*Midas oedipus*) from Colombia, two Springboks (*Gazella euchore*) from South Africa, two Small Hill Mynahs (*Gracula religiosa*) from India, deposited; two Common Jackals (*Canis aureus*), two White Cranes (*Anthropoides leucogeranos*), two Imperial Fruit Pigeons (*Carpophaga*, sp. inc.), a Purple-shouldered Pigeon (*Crocopus phoenicopterus*), three Andaman Teal (*Querquedula albigularis*) from India, received in exchange.

OUR ASTRONOMICAL COLUMN.

SEARCH EPHEMERIS FOR ENCKE'S COMET.—A circular from the Centralstelle at Kiel furnishes the following ephemeris for the expected appearance of Encke's Comet:—

Ephemeris for 0h. Berlin Mean Time.

1901.	R.A. h. m. s.		Decl. ° ′
Aug. 8	6 16 55	...	+31 34·4
9	23 44	...	31 29·0
10	30 40	...	31 22·2
11	37 42	...	31 13·7
12	44 52	...	31 3·5
13	52 7	...	30 51·5
14	6 59 29	...	30 37·8
15	7 6 56	...	+30 22·2

VARIATION OF EROS.—In the *Comptes rendus*, vol. cxxxiii, pp. 262–265, M. André presents the results of the reductions of observations made at the observatory of Lyons since February 1901. Three observers made independent estimations of the magnitude of the planet at intervals of five minutes. It is notable that the determination of the times of minima appears much more accurate than that of the maxima, the mean errors from a single observation in the two cases being ± 3·3 and ± 7·2 minutes respectively.

From the whole of the observations the period deduced is

5h. 16m. 15·2s.

Further notes are given concerning the change in form of the light curve, consisting chiefly in the two sections becoming more nearly equal than was the case when the variability was first detected.

CELESTIAL OBJECTS HAVING PECULIAR SPECTRA.—*Circular No.* 60 from the Harvard College Observatory contains a list of 59 objects found by Mrs. Fleming from an examination of the Draper Memorial photographs, which exhibit peculiarities in their spectra. The positions are given for 1900, and accompanying notes describe the special features of the objects, which include 19 gaseous nebulæ, 6 bright line stars of Type I., and 22 stars of Type V. One of the gaseous nebulæ is noted as showing bright lines at λ5007, Hβ, Hγ, Hδ and Hϵ. A great number of these objects (28) are situated in the region of the Large Magellanic cloud.

It is also noted that the bright Hβ in the spectra of η Centauri (A.G.C. 17739), and κ Apodis (A.G.C. 20878), has been found to show indications of variability.

MOTION OF α PERSEI IN THE LINE OF SIGHT.—Prof. H. C. Vogel has responded to the appeal made by Mr. Newall for observations of the radial velocity of this star, which, from spectrograms obtained at the Cambridge Observatory, showed indications of a period of variability of 4·2 or 16·8 days. The spectra obtained at Potsdam are only about half the scale of the Cambridge plates. Photographs of the spectrum were obtained on six nights during November 1900, for preliminary testing, and others during December 1900 and January 1901, which were measured and reduced for velocity. The result of determinations from thirteen plates is given as −3·22 km., relative to the sun. No indication of variation is found, and the adopted velocity is in fair accordance with the value −2·4 km. obtained by Campbell. (*Astrophysical Journal*, xiii. pp. 320–323.)

METALS AS FUEL.[1]

A CAREFUL metallurgist,[2] writing in the eighteenth century, claimed that "every matter which is combustible either wholly or in part, is called fuel, the pabulum of fire." The word is, however, usually restricted to substances which may be burnt by means of atmospheric air with sufficient rapidity to evolve heat capable of being applied to economic purposes. The latter definition covers certain metals, though it was doubtless framed to include only carbon and associations of carbon and hydrogen, such as coal. The omission from the definition of the reference to atmospheric air would enable the list of metals which might be used as fuel to be widely extended.

It has long been known that metals will burn, and it would be easy to show that the history of inorganic chemistry is epitomised and enshrined in a mass of litharge, which is simply burnt lead. Successive generations of chemists, from Geber in the eighth century to Lavoisier in the eighteenth, studied litharge carefully before the latter proved partly by its aid the identity of respiration, calcination and combustion. Into this history I need not enter, but it may be pointed out that Sir Isaac Newton[3] had a clear idea as to the possibility of burning metals. "Is not fire," he asks, "a body heated so hot as to emit light copiously?" . . . "for what else is red hot iron than fire?" and he significantly adds, "metals in fusion do not flame for want of copious fume." He was, moreover, aware that a mixture of lead and tin "suitably heated" does emit "fume and flame," and, in fact, a mass of 1 part tin and 4 parts lead, which looks metallic, will, if it is kindled, continue to burn like an inferior variety of peat, leaving an ash-like product which may be used as an enamel.

I propose to show that metals may be burnt for the sake of the heat and light they produce, just as ordinary fuels are burnt, except that in burning ordinary fuels combustion is often effected in two distinct steps or stages, in the first of which carbonic oxide is formed, and in the second carbonic acid, the products in both cases being gaseous. When metals are burnt, the products of combustion are solid, or condense to solids, and they therefore present a marked contrast to ordinary fuels which, as has just been stated, yield on combustion gaseous products. As I shall have but little to say about the light which attends the combustion of metals, I may as well dismiss the subject by reference to a familiar application of the burning of metals for the purpose of illumination. It is easy to fire electrically a portion of what is known as a "magnesium star," and a "fire-ball" of magnesium attached to a parachute is beautifully packed in this shell, for the loan of which I am indebted to the authorities of the Royal Arsenal, Woolwich, and when the shell explodes the stars burn and illuminate the enemy's position in the darkness of night, so that guns may be laid to place projectiles in the enemy's lines.

Before proceeding further, I want to use the electric furnace as affording a basis of comparison with the method of producing high temperatures by the combustion of metals, which I shall proceed to show subsequently. A current of 100 amperes at 200 volts is passed by carbon poles into the furnace in which pig iron is being melted; directly the last piece of iron has become fluid, the temperature of the fused pool must be about 1300° C. The fluid mass is reflected on the screen merely to give some indication as to the appearance of such a mass at 1300° C., and not to afford a test of the capabilities of the electric furnace. Later on I hope to show that a far higher temperature can be produced by very simple means in a receptacle of about the same capacity as the laboratory part of the furnace.

Henceforth in the course of this lecture metals will be burnt for the sake of the heat which is the result of their combustion. From this point of view metallurgists have long used metals as fuel, often without due recognition of the fact, but case after case could be cited in which conducting definite metallurgical operations is made possible by burning portions of the metal or metals under treatment. Time will perhaps be saved if I place in sharp contrast the use of ordinary fuel and metallic fuel, even though it takes us rather far back, for I do not want it to be thought that the use of metals as fuel is new, although their adoption for this purpose has recently been greatly stimulated. Here is a mass of very ordinary iron ore picked up on a heath in Surrey, which skirts the site of what was once the ancient forest of Anderida. The pre-historic dweller on the heath who used the beautiful flint arrowheads, which are found near the iron ore, merely burnt the wood of the forest to warm himself or to cook his food. But the Britons whom Cæsar found in Andreaswold smelted iron with the wood of the forest trees, from which they prepared charcoal, and smelting iron was actively conducted in Queen Elizabeth's reign, and even survived into the last century in the district I am contemplating. But in smelting iron, carbon became associated with it and played a subtle part, rendering the iron precious for certain purposes and useless for others. Iron had therefore to be "decarburised" with a view to its conversion into steel, and in doing this metallurgists for centuries truly burnt some of the iron itself, using it actually as fuel. I will only add that the use of metals as fuel assumed magnificent proportions in the hands of Bessemer, as may be illustrated by an experiment. A few pounds of a compound of iron, carbon, silicon and manganese is melted in the wind furnace, simply used because it affords a convenient method of melting the mass, which is turned into a small Bessemer converter. A stream of oxygen is directed into the fluid mass. Air would do, but with so small a mass the free nitrogen would cool it too rapidly. In a few seconds the carbon in the fluid will be burnt away, nevertheless the mass gradually becomes hotter and hotter, notwithstanding the loss of carbon. A brilliant pyrotechnic display is the result. The metalloid silicon is now burning, and then brown fumes of iron and manganese pass freely off; these metals are truly burning and are maintaining the heat of the bath, and the presence of their fumes shows that it is time to stop the operation. The temperature is somewhere near 2000° C., but according to some recent investigations of Prof. Noel Hartley (*Phil. Trans.*, vol. cxcvi. series A, p. 479, 1901), a temperature of more than 2000° C. is attained in the converter. Bessemer gave the world in 1856 cheap steel; we therefore owe to him the inestimable benefits that are the results of that gift, and I ask you to bear in mind that his great service to the industry of which we as a nation are so justly proud rested on the possibility of using metalloids and metals as fuel. I have already promised that in the course of the lecture I will show some experiments in which the temperature will be a thousand degrees higher than in the one you have just seen. In the Bessemer process the products of combustion are both gaseous and solid, and in a very ordinary case the heat engendered by the carbon of the bath which evolves gases is only half that which results from the combustion of the silicon, iron and manganese which yield solid products. As regards the "open-hearth process," in the phase of it which is known as the "pig and ore" process, oxygen is presented and heat is produced under similar conditions to those we shall consider subsequently in the case of the action of aluminium on ferric oxide.

Heat Evolved by Burning One Gramme of the Following Elements.

Element.	Product of combustion.	Calories.
Aluminium	Al_2O_3	7250
Magnesium	MgO	6000
Nickel	NiO	2200
Manganese	MnO_2	2110
Iron	Fe_2O_3	1790
,,	Fe_3O_4	1580
,,	FeO	1190
Cobalt	CoO	1090
Copper	CuO	600
Lead	PbO	240
Barium	BaO	90
Chromium	Cr_2O_3	60
Silver	Ag_2O	30
Carbon	CO_2	8080
,,	CO	2417
Silicon	SiO_2	7830

This table, which contains the relative calorific powers of different metals and metalloids as compared with carbon, indicates the advantage which certain metals possess over carbon for use as fuel. The question at once presents itself, at what temperature will such metals as can be used for fuel begin to abstract oxygen from the air? The answer is, it depends on

[1] A Friday Evening Discourse delivered on February 22, 1901, at the Royal Institution, by Sir W. Roberts-Austen, K.C.B., F.R.S. The lecture consisted mainly of a series of experiments conducted at very high temperatures, and apart from them it is difficult to give a continuous abstract of it.

[2] C. E. Gellert, "Metallurgic Chemistry," trans. by I. S. (London, 1776), p. 74.

[3] "Optic," pp. 316–319, quoted by Shaw in his edition of the works of Boyle, vol. ii. p. 400.

the method by which the metals are prepared. If they are in a chemically active state, as lead is which has been prepared from tartrate of lead, they will, in many cases, take fire in air and burn at the ordinary temperature. This lead burns readily when shaken in air. If this mass of uranium, for which I am indebted to M. Moissan, is filed in air, the detached particles will ignite. Metallic iron which has been reduced by hydrogen from its oxide at a temperature below 700° C. will also take fire and burn in air at the ordinary temperature, a point of extraordinary interest in relation to the allotropy of iron (Osmond and Cartaud, *Ann. des Mines*, August 1900). Metals in this chemically active state are said to be "pyrophoric."

So far as I am aware, metals in this chemically active state have not been used as fuels. Neither am I aware that any use has been made of the allotropy of metals as enabling them to be used as fuel, but Prof. Graham once told me that pyrophoric iron had been suggested for warming ladies' muffs, the intention being to place the iron in a small receptacle and to admit air gradually as warmth was needed. Sir Henry Trueman Wood also remembers the suggestion, but tells me that he can find no record of it in the *Journals* of the Society of Arts. I may just mention that the burning of metallic antimony plays a very important part in roasting silver ores, and the behaviour of the metal is so peculiar while burning that I must pause to show it you. [A melted globule of antimony, if thrown on to a tray of paper, darts about and cannons from the sides, leaving a track of dark oxide on the paper.]

The metal I am going to employ as fuel is aluminium, the oxygen for its combustion being supplied by metallic oxides, which readily part with their ogxyen to aluminium if it be raised to certain definite temperatures. This question of the transference of oxygen from one metal to another, which results in the liberation of the metal attacked, is of special interest to us at the Royal Institution, for it undoubtedly originated within these walls and is due to Sir Humphry Davy. He discovered potassium in 1807, and in 1809 attempted to remove the oxygen from alumina by heating it with metallic potassium. He says (*Phil. Trans.*, part i. 1810, p. 60), "if I had succeeded in isolating the metal I should have called it *alumium*." His success was imperfect, but he certainly did obtain, by the intervention of metallic potassium, an alloy of aluminium and iron. It remained for Wöhler to prepare pure metallic aluminium from its chloride in 1827, and for Henri Saint Claire Deville, who began to work in 1854, to establish the metallurgy of aluminium on an industrial scale. As regards the reduction of metals from their chlorides, Wöhler (*Ann. der Chemie*, vol. cvi. p. 118) obtained crystalline compounds of chromium and aluminium and Michel (*ibid.*, vol. cxv. p. 102; *ibid.*, vol. cxiii. p. 248) compounds of aluminium with manganese, iron, nickel, tungsten, molybdenum and titanium. Levy (*Comptes rendus*, vol. cvi. p. 66) obtained an alloy of titanium and aluminium, Beketoff (*Ann. der Chemie*, vol. cx. p. 374) an alloy of barium with aluminium from the chloride of barium mixed with baryta. Dr. Goldschmidt (*ibid.*, May 1898) has given references to these authorities in a recent valuable paper. In 1856, Charles and Alexandre Tissier (*Comptes rendus*, vol. xliii. 1856, p. 1187) observed the fact which is the starting point of the experiments I have to show you. They found that aluminium decomposes the oxides of lead and of copper, much heat being evolved by the reaction.

They do not appear to have used aluminium in a finely divided state, and therefore failed to reduce certain metals from their oxides which are now known to be perfectly easy to reduce. It was not until comparatively recently that the use of aluminium for separating other metals from their oxides assumed serious proportions. Claude Vautin showed on June 13, 1894, at a soirée of the Royal Society, a few metals, and among them carbon-free chromium and manganese, which he had prepared, and as he undoubtedly gave the impulse that started much of the subsequent work in this direction, it may be well to give the description which was appended to the specimens he showed. It runs as follows:

Specimens of Metallic Chromium, Manganese, Tungsten Iron, &c., free from Carbon, also fused Alumina, obtained during reduction of the metallic samples.

The specimens of metallic chromium, manganese, &c., have been reduced from their oxides by means of metallic aluminium. The oxide of the metal to be reduced is intimately mixed with finely divided aluminium, and heated in magnesia-lined crucibles. The heat produced by the oxidation of aluminium during the operation is sufficient to fuse alumina, a specimen of which is exhibited.

The subject is, however, in a sense your own, for, so far as I know, the lecture on "The Rarer Metals and their Alloys" (NATURE, May 2 and 9, 1895), which I delivered here in 1895, was the first occasion on which the reducing action of aluminium was demonstrated on a comparatively large scale, and covered an extended series of metallic oxides. Since that time great progress has been made, the most noteworthy advance being in the direction of the use of aluminium for the sake of the heat afforded by its combustion as a true fuel, the oxygen being derived, not from the air, but from a metallic oxide. In order that I may be clear, let me repeat that when coal is burnt the oxygen is derived from the air. When aluminium is used as a fuel the oxygen is derived from a metallic oxide, the metals change places, the aluminium is oxidised,

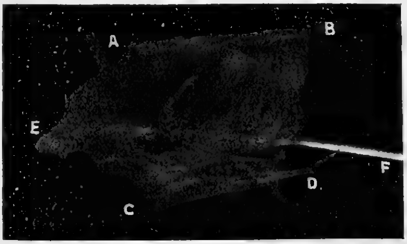


FIG. 1.—The oxidation in air of an amalgamated wire of aluminium, E F. The films of alumina, A B and C D, are those which first formed on the wire.

and the other metal set free from its oxide. This part of the subject must be carefully approached, and the question at once arises as to what extent the aluminium must be heated before it will begin to abstract oxygen from air or from an oxide. It is well known that the metal aluminium will not oxidise sensibly in the air at the ordinary temperature, but the presence of a little mercury enables it to oxidise readily. Le Bon (*Comptes rendus*, October 29, 1900, p. 707) has shown how minute the quantity of mercury may be. This wire of aluminium to which a thermo-couple is attached will, if a mere trace of mercury be rubbed on its surface, become rapidly heated by oxidation, the temperature rising to 102° C., while at the same time a fungoid-like growth of alumina forms on its surface (see Fig. 1). Aluminium foil will burn readily in oxygen if its combustion

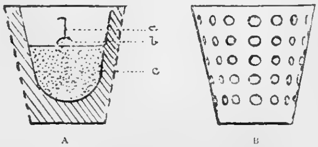


FIG. 2.—Crucible in which the reduction of metallic oxides is effected. A, diagrammatic section of the perforated sheet-iron crucible, B, lined with magnesia; *c* is the mixture of aluminium and the metallic oxide to be reduced to metal; *a* is a piece of magnesium ribbon placed in a mixture, *b*, of aluminium and some readily reducible oxide.

be started by a glowing fragment of charcoal. The temperature at which aluminium will abstract oxygen from a metallic oxide will depend on the oxide submitted to its action. Three cases may be taken: (1) Lead oxide and granulated aluminium may be ignited by a match, as may also silver oxide (Ag_2O), for it parts with its oxygen very readily. (2) Chromium oxide (Cr_2O_3) and granulated aluminium burns slowly and requires rather a high temperature to start the reaction. Oxide of iron (Fe_2O_3) and granulated aluminium also requires the presence of a readily reducible oxide to start the reaction. On the other hand, (3) a mixture of sodium peroxide, carbide of calcium and granulatedaluminium may be started by a drop of water by the mere inflammation of the acetylene. In all these cases, or in any other case, the products are solid, for if any of the reduced metal is volatilised it soon condenses, and may be collected, usually in an oxidised form.

In using aluminium as fuel the object, of course, is to produce intense heat, and returning to this mass of iron ore from the Surrey heath it may at once be stated that an oxide of iron,

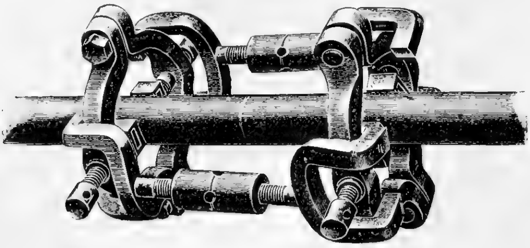


FIG. 3.—The clamps used or welding tubes up to four inches in diameter.

ferric oxide, is the most convenient oxide to use, partly because it is inexpensive.

Many of my audience already know that the recent investigations having for their object the use of aluminium as a source of heat have been conducted by Dr. Hans Goldschmidt, of Essen, and it is through his labours that metallurgy enters upon an entirely new phase. It would be difficult to offer him fuller or more unstinted praise than that. You will, I trust, soon realise how much industry is indebted to him. In its simplest form his process consists in igniting a mixture of oxide of iron, ferric oxide and finely divided aluminium. To this mixture the name of "thermit" has been given, and several varieties of it, adapted to various kinds of work, are used by Dr. Goldschmidt at the works of the Allgemeine Thermit-Gesellschaft at Essen-Ruhr.

The mixture is placed inside a crucible (Fig. 2) and is ignited by a small piece of magnesium wire, which serves as a kind of wick if it is placed in a little heap of calcium sulphate and aluminium. Such a mass will now be lighted, and you see intense heat is produced. [When the operation was conducted in accordance with the above indications, the theatre was brilliantly illuminated by the intense light produced. A mass of metallic chromium weighing about 100 lbs., reduced to the metallic state as above described, was exhibited.] The aluminium abstracts oxygen from the oxide of iron, and a sufficiently intense heat is produced, not only to melt

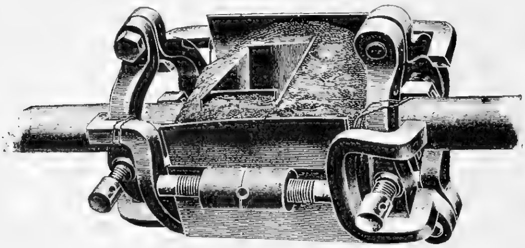


FIG. 5.—Casing packed round with moulding sand in readiness for the welding operation.

the iron which is liberated from its oxygen, but to melt up the slag and, further, to leave a considerable surplus of heat, which is available for doing other work. No known pyrometer will enable the heat to be measured. I believe it to be about 3000° C. The aluminium plays the part of a fuel, and this table shows the advantage aluminium possesses as compared with carbon for the particular work required of it.[1]

The Reduction of Fe_2O_3 *to Iron by Aluminium and by Carbon.*

	Aluminium.	Carbon.
Compound produced ...	Al_2O_3	CO
Amount of reducing agent required to produce 1 kilo. of iron ...	0·484 kilo.	0·321 kilo.
Amount of heat produced by oxidation of the reducing agent ...	3456 calories	770 calories
Heat required to reduce the Fe_2O_3	1796 ,,	1796 ,,
Heat required for fusion of the slag	548 ,,	
Heat required for fusion of iron	362 ,,	
Total heat required ...	2706 ,,	1796 ,,
Residual heat available	750 ,,	− 1026 ,,

On the aluminium side some 750 calories (units of heat) are available to do work (3456 − 2706 = 750 calories). On the carbon side there is a deficiency of no less than − 1026 calories. As regards the crucibles, they may be made of alumina, the solid product which is the result of the combustion of aluminium. They may also be made of magnesia or mended with magnesia. I shall have more to say about the solid product of the combustion subsequently. The practical

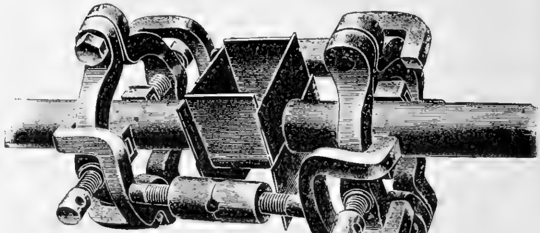


FIG. 4.—Tubes clamped together with a casing of thin iron round the junction to be welded.

application of the process is as follows. The ignited and molten mass in the crucible is so intensely hot that it may be made to unite surfaces of steel that require to be joined, such as the ends of lengths of rails. If I may use a simile which enables me to describe the method rapidly, the fluid contents of the crucible are applied as a hot bandage might be applied to wounded or severed surfaces in the human body which require medical treatment to facilitate healing or to cause them to unite. It may be objected that the fluid contents of the crucible would set as a whole round the metallic junction and give trouble, but this is not the case, for a layer of fluid alumina appears both to coat the rod, tube or rail which has to be welded, and to set in a mass which can be readily detached after the work is done. The casings (Figs. 4 and 5) are protected in the same way. The diagrams (Figs. 3, 4, 5) need but little comment, as they sufficiently indicate the method adopted in the case they represent. These figures were used to illustrate a paper by Mr. E. F. Lange (*Journal* of the Iron and Steel Institute, 1900, No. ii. p. 191). [I was indebted to him for the loan of small appliances of a similar kind to enable me to demonstrate to the audience the welding of steel tubes, and the operation was shown on as large a scale as safety would

[1] These data are from a paper by Prof. Kupelwieser, of Leoben, *Oesterreichische Zeitschrift für Berg- und Huttenwesen*, vol. xlvii. 1899, p. 145–149.

permit.] The welding of three miles of electrical tramway rails was successfully effected in Brunswick in May 1900.

As regards the comparison of the use of aluminium as fuel with the electric arc, M. Camille Matignon (*Moniteur Scientifique Quesneville*, No. 702, Juin 1900, p. 357 *et seq.*), in a very interesting discourse recently delivered in Paris, has instituted a comparison between the Goldschmidt process and the electric furnace. Quoting Moissan ("Le Four électrique," p. 19), he shows that in reducing titanic acid by carbon in the electric furnace having a "laboratory space" of 800 cubic centimetres, 300 horse-power absolute were employed, producing per second 190,500 calories by burning 1·08 kilograms of aluminium. On the other hand, by burning 3·2 kilograms of ferric oxide during one minute in a crucible of about the same

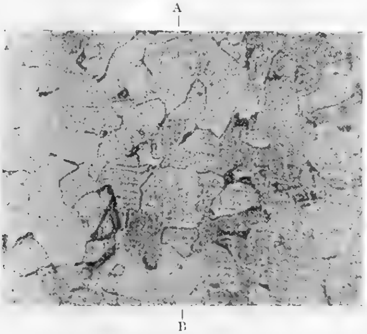


FIG 6.—Section of the welded test piece (Fig. 7), showing crystals passing across the line of weld, A B. Magnification 140 diameters.

capacity as the laboratory of the electric furnace, the rate of evolution of heat is equivalent to 375 horse-power absolute; the latter process does not, however, work continuously, but could readily be made to do so. It should be pointed out that an impure variety of aluminium can be used, and that if the heat needed to effect a given operation is but moderate, the aluminium may be diluted by the presence of an inert substance.

The photomicrograph (Fig. 6) is from a little test piece of wrought iron (Fig. 7) which was cut in two. The carefully faced surfaces were then clamped together, and I united them into an excellent weld, without any previous experience in conducting such an operation. No line of demarcation can be seen, and the crystals pass over the line A B, which I know by measurement to be that of the actual weld.

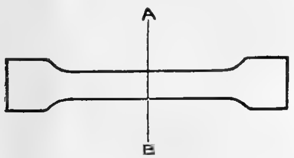


FIG. 7.—Test piece of wrought iron welded at A B. See Fig. 6 for micro-section.

The very hot molten iron may be used in a somewhat different way for repairing defective castings. In this case the slag is carefully poured off the fluid iron in the crucible and the iron is then poured into the defective part in the casting which it is required to mend, a guiding rim of some refractory material being provided. By mixing other metallic oxides with the iron oxide, the metals they contain are reduced and alloy themselves with the iron, and the composition of the defective casting can thus be matched. In connection with the repairs of fractured or defective steel castings, the possibility of producing directly steel of a suitable degree of carburisation is important. This may readily be effected by mixing fragments of cast iron with the "thermit," thus 70 to 90 grammes of cast iron mixed with 1000 grammes of thermit gives a very fine-grained and workable steel. One useful application of the process is for locally softening hardened armour plates in the positions where the bolts and screws have to be inserted through the holes drilled to admit them. This is effected by placing a little fluid "thermit" on the spot where the plate has to be drilled and the heat softens the hardened surface. It should also be remembered that, with reference to the repairs of defective parts of machinery, a suitable admixture of metallic oxides with the ferric oxide, such as those of chromium, nickel or manganese, may be reduced together with the iron derived from the ferric oxide. Richly carburised iron may be added to the molten mass, and in this way any quality of steel may be produced.

This latter reference to metallic oxides reminds us of the original use for which the finely divided aluminium was employed, namely, as a reducing agent for the rarer metals and not for the sake of the heat evolved by the reaction. This portion of the subject I dealt with at the Royal Institution six years ago, but there have been great advances since. It would have been tedious to have conducted the experiments before you, as the crucibles would have taken so long to cool; but in each of these crucibles, which will now be broken open, I hope to find a small mass of metal, which, until now, has not left the spot in which it was reduced. [About a pound of nickel and a pound of cobalt were then produced from the respective crucibles in which they had been reduced].

Manganese and chromium containing only small quantities of carbon are now produced on a large scale for industrial use. As regards the reduction of metals and alloys from their oxides by burning aluminium, the following are the most recent results that have been obtained (*Stahl und Eisen*, March 24, 1901). The use of carbon-free chromium in connection with the metallurgy of steel is an exceedingly useful development of the methods we have considered. Hitherto, the addition of ferro-chrome to steel has involved a loss of from 20 to 25 per cent. of the chromium, while with pure chromium the loss is slight. Moreover, the addition of ferro-chrome incidentally raises the percentage of carbon, and steel containing, for instance, 2·5 per cent. of chromium should not have more than from 0·15 to 0·20 per cent. of carbon, and this can only be attained by the use of pure chromium. In the manufacture, also, of tool steel, the percentage of chromium may reach from 6 to 10 per cent. and even higher, a result which is only rendered possible by the use of pure chromium. In the same way, in connection with the metallurgy of copper, the possibility of providing carbon-free manganese is important, as is also the preparation of cupro-manganese free from iron. Alloys of manganese with zinc and with tin are likely to prove of value. Many uses have been found for the alloy containing 80 per cent. of zinc and 20 per cent. of manganese, while it is anticipated that the alloy containing 50 per cent. of tin and 50 per cent. of manganese will also prove to be important. Use has also been found for an alloy of 70 per cent. manganese and 30 per cent. chromium. Ferro-titanium, with 20 to 25 per cent. of titanium, and alloys of titanium and manganese containing from 30 to 35 per cent. of titanium, have also been produced. Titanium, moreover, absorbs nitrogen, and ferro-titanium is found to be very useful in producing sound steel castings. I, quite independently of Dr. Goldschmidt, succeeded in the preparation of alloys of iron with from 3 to 25 per cent. of boron, the alloy containing 3 per cent. of boron proving to be beautifully crystallised. Dr. Goldschmidt states that definite results have not been obtained in attempts to utilise it. I am still investigating this most interesting subject. Dr. Goldschmidt has obtained ferro-vanadium, the best results being given with steel containing 0·5 per cent. of vanadium. He has also prepared an alloy of lead and barium containing 30 per cent. of barium, which affords an example of the possibility of forming alloys of metals with those of the alkaline earths by this process.

It only remains for me to direct your attention to the nature of the solid product of the combustion of aluminium, which is alumina often of a high degree of purity, and in a specially interesting form. The alumina from the reduction of oxide of chromium, when it is allowed to cool, forms large ruby-tinted crystalline masses, closely resembling the natural ruby. I have now to show you on the screen some rubies and sapphires produced as an incident of this beautiful process. The blue sapphire mass is, however, only translucent, not transparent. The ruby crystals are often very beautiful, as these slides show. Rubies placed in a vacuum tube and subjected to the bombardment of an electric discharge are, as Sir William Crookes has taught us, beautifully phosphorescent. I have here in this tube some thin crystalline plates of artificial ruby; they become beautifully phosphorescent when the current from the induction coil is passed through the tube, and by the kindness of Sir William Crookes I can show you some true rubies treated in a similar way. The behaviour of the artificial rubies in the vacuum tube is not quite as brilliant as that of the natural ones, but hitherto no special attention has been devoted to their preparation; they are simply thin plates broken from a large crystalline mass of slag such as that on the table. I may add that this variety of corundum produced by the burning of aluminium is very hard, and may be used, not only for the same purposes as ordinary corundum, but for lining the crucible in which the operations are conducted, so that the product of combustion takes its place in conducting the process. My warmest thanks are due to Dr. Goldschmidt for lending me the beautiful specimens on the table, and to Mr. W. H. Merrett for his aid in conducting the experiments.

I have set before you the considerations respecting the use of metals as fuel simply as they appear to flow. I trust that the adoption of the title of this lecture has been justified by the evidence given as to the possibility of using metals as fuel in the strictest sense of the word. It is well to be accurate on this point because we are told that the first known appearance of the word "fuel" in the English language occurs in a poem (*Coeur de Lion*, 15th century), and seems to have been a misinterpretation of the old French word *fouaille*, and was adopted in the belief that sustenance for the body and food for the flames are synonymous. Widening our view of metals by grouping them with fuels will be acceptable because fire and flame powerfully appeal to our thoughts. We "kindle" enthusiasm, and add "fuel" to the fire of ambition, in fact we constantly use fire, flame and fuel as similes, and any prospect of extending their use to us as such by enlisting metals in the service will be welcome. An early Italian metallurgist, Vanoccio Biringuccio, might not have thought so, for I find that, writing in the sixteenth century, he quaintly devotes the last chapter of a work on metallurgy to "Fires which burn and leave no ashes."[1] In this chapter he appeals to envy, hatred, malice and other products of a kindled imagination, and traces their analogies to fuel and flame, but he speedily takes leave of his readers in alarm at the prospect such a treatment of the subject presents.

The burning of aluminium as fuel gives us sapphires and rubies in the place of ashes, and metallic fuel is burnt, not by the air above, but by the oxygen derived from the earth beneath, as it occurs in the red and yellow oxides to which our rocks and cliffs owe their colour and their beauty.

AGRICULTURAL EXPERIMENTS.

A NUMBER of reports on agricultural experiments conducted by provincial colleges have reached us, of which the most comprehensive is that issued by the Agricultural Department of the Durham College of Science. Most of the field-work that this report deals with was planned and started by Prof. Middleton's predecessor, and the results are becoming more valuable each year. It is a report that should be in the hands of every one that is interested in agricultural progress, though no one need expect to find it light reading.

In the north of England, as in many other parts of the country, the turnip crop suffers severely from finger and toe, and the work of the Durham College of Science is throwing much fresh light on this subject. Hitherto the disease has chiefly been combated by the application of large dressings of slaked lime applied a year or less before it was intended to grow a cruciferous crop. In this way the fungus and its spores are destroyed more or less effectively, but at a larger cost than agriculture can now well bear. It appeared, however, that if lime can get rid of the disease when the substance is applied only a short time before the crop that the fungus affects is to be grown, the clearance of the soil will be much more effectual—or will be accomplished at less outlay—if the trouble is attacked at its fountainhead, namely, directly after an infected crop has been grown. With this object in view, a field that had grown a much-diseased crop in 1896 was divided into five plots in the autumn of that year, one of the plots being soon afterwards treated with 2½ tons per acre of ordinary burned lime, while another plot did not receive its dressing till the autumn of 1899. Following the four-course shift the field was again under turnips in 1900, with the following result per acre:—

	Weight of roots				Percentage	
	Sound		Diseased		Diseased and destroyed	Sound
	Tons	cwt.	Tons	cwt.		
No lime	13	18	2	17	41·6	58·4
Lime applied, Feb. 1897...	20	11	0	13	10·1	89·9
,, ,, Nov. 1899...	15	12	1	13	29·2	70·8

The above figures hardly put the case so strongly as they might, for whereas when the roots were diseased to the extent of 41·6 per cent. and 29·2 per cent., such roots were practically valueless, the infected roots were far from the putrescent stage when the percentage of disease was 10·1.

The now well-known Cockle Park experiments on "manuring for mutton" are described at length in the above report, and are popularly presented in a circular issued by the Northumberland County Council. In this circular the results for each plot are shown by a diagrammatic sheep, the sections of whose body represent (*a*) the growth due to the soil in its unimproved condition; (*b*) the growth induced by manurial treatment; and (*c*) the portion of such growth as is needed to cover the manurial outlay. So far a large dressing of basic slag applied four years ago, and not repeated, has proved most effective; whereas the lowest place is taken by a moderate dressing of lime. A corresponding circular deals with the experiments on turnip manuring.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A WELL-ARRANGED calendar of the Merchant Venturers' Technical College, Bristol, showing the courses of work to be taken in the forthcoming session and the facilities for study, has been received. At the end of each syllabus a useful list of books of reference is given, in addition to the usual list of text-books. We assume that the reference books recommended are to be found in the school library, or on the laboratory bookshelf.

A VACATION course of lectures and observations connected with nature study, for teachers in rural schools, was opened at the Harper-Adams Agricultural College, Newport, Salop, on August 1 with an address by the principal, Mr. P. Hedworth Foulkes. The primary object of nature teaching is, he pointed out, to encourage and promote in children the power of observation, so that when the school days are over the pupil is in full and complete sympathy with natural knowledge, and takes an intelligent interest in it. The course has been arranged to help teachers who are desirous of cultivating this spirit of observation and inquiry in their pupils.

PROF. W. J. ASHLEY, now one of the professors of economics in the Harvard University, Cambridge, Massachusetts, has been appointed to the first or organising chair of the future faculty of commerce in the University of Birmingham. Prof. Ashley was a Brackenbury scholar at Balliol College, Oxford, and obtained a first in history in 1881, followed by a fellowship of Lincoln College. For three years he was college tutor in Oxford, lecturing in large classes in economics and history. Towards the end of the eighties he was called to a chair of economics at Toronto, and after a short time the staff of Harvard University went out of the ordinary course to enable provision to be made among them for him, and there he has occupied the chair of economic history since 1892, the chair of economics itself being held by Prof. Taussig. It is understood to be the wish of the council and senate of the University of Birmingham that the professor should devote his first year to investigation and consolidation of ideas, in consultation with men of business in this and other countries,

[1] "De la Pirotechnia," 1540, p. 167. (Venice). "*Del fuocho che consuma et non facenere.*"

and that the faculty of commerce should not be constituted, or regular teaching begin, until the following session.

THE Royal Commissioners for the Exhibition of 1851 have made the following appointments to science research scholarships for the year 1901, on the recommendation of the authorities of the several universities and colleges. The scholarships are of the value of 150*l*. a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any university at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country:—J. A. Craw, University of Glasgow; F. Horton, University of Birmingham; A. Slator, University of Birmingham; R. B. Denison, Yorkshire College, Leeds; G. Owen, University College, Liverpool; G. Senter, University College, London; F. W. Rixon, Owens College, Manchester; T. Baker, Durham College of Science, Newcastle-on-Tyne; S. C. Laws, University College, Nottingham; Alice E. Smith, University College of North Wales, Bangor; J. Hawthorne, Queen's College, Belfast; R. K. McClung, McGill University, Montreal; C. W. Dickson, Queen's University, Kingston, Ontario; G. Harker, University of Sydney; Dr. J. M. Maclaren, University of New Zealand. The following scholarships granted in 1900 have been continued for a second year on receipt of a satisfactory report of work done during the first year:—C. E. Fawsitt, University of Edinburgh; V. J. Blyth, University of Glasgow; J. Moir, University of Aberdeen; Dr. W. M. Varley, Yorkshire College, Leeds; J. C. W. Humfrey, University College, Liverpool; S. Smiles, University College, London; Alice L. Embleton, University College of South Wales and Monmouthshire, Cardiff; J. A Cunningham, Royal College of Science, Dublin; W. S. Mills, Queen's College, Galway; J. Patterson, University of Toronto; W. C. Baker, Queen's University, Kingston, Ontario; J. Barnes, Dalhousie University, Halifax, Nova Scotia; J. J. E. Durack, University of Sydney. The following scholarships granted in 1898 and 1899 have been exceptionally renewed for a third year:—L. N. G. Filon, University College, London; J. W. Mellor, University of New Zealand; F. W. Skirrow, Yorkshire College, Leeds; C. G. Barkla, University College, Liverpool; W. Campbell, Durham College of Science, Newcastle-upon-Tyne; L. Lownds, University College, Nottingham; Dr. J. T. Jenkins, University College of Wales, Aberystwyth; R. D. Abell, University College of North Wales, Bangor; B. D. Steele, University of Melbourne.

SCIENTIFIC SERIAL.

American Journal of Science, July.—Geology of the Shonkin Sag and Palisade Butte Laccoliths in the Highwood Mountains of Montana, by W. H. Weed and L. V. Pirsson.—On the manganese ore deposits of the Queluz (Lafayette) district, Minas Geraes, Brazil, by O. A. Derby.—On the bituminous deposits situated at the south and east of Cardenas, Cuba, by H. E. Peckham. On the north of Cuba there is a tract of country more than 4500 square miles in area, the springs and wells of which give indications of the existence of liquid bitumens of varying density. The oil which has been obtained resembles the oils of Russia, but it is doubtful if, in view of the enormous production which recent developments in Texas and Indiana promise, there is at present any encouragement for even experimental drilling in Cuba.—Mineralogical notes, No. 2, by A. F. Rogers. A description of new types of calcite and galena, together with a note of new localities for some rare minerals.—A new solution for the copper voltameter, by W. K. Shepard. A saturated solution of copper sulphate is boiled for a short time to expel the air and then kept for about an hour at 100° C. in contact with metallic copper in order to neutralise the solution. About ·05 per cent. of ammonium chloride was then added. Using this solution it was found that the weight of copper was practically independent of the temperature between 20° and 40° C; the solution may be used a large number of times, and the results are independent of the current density between the limits of ·02 and ·07 ampere per square centimetre.—The thermomagnetic and galvanomagnetic effects in tellurium, by M. G. Lloyd.—Additions to the avifauna of the Bermudas, with diagnoses of two new subspecies, by A. H. Verrill.—The induced alternating current discharge studied with reference to its spectrum and especially its ultra-violet spectrum, by A. W. Wright and E. S. Downs.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 23.—"Preliminary Statement on the Prothalli of *Ophioglossum pendulum* (L.), *Helminthostachys zeylanica* (Hook), and *Psilotum*, sp." By William H. Lang, M.B., D.Sc., Communicated by Prof. F. O. Bower F.R.S.

During a recent visit to Ceylon and the Malay Peninsula, the author found prothalli of *Ophioglossum pendulum* and *Helminthostachys zeylanica* as well as a single specimen, which there is reason to regard as the prothallus of *Psilotum*. This paper gives a brief account of the mode of occurrence and external form of these three prothalli.

Ophioglossum pendulum. The prothalli were found in the humus collected by an epiphytic fern. They were wholly saprophytic, devoid of chlorophyll and of a yellowish-white colour. An endophytic mycorhiza is present in them. The prothallus is radially symmetrical, the older ones consisting of a number of short cylindrical branches radiating in all directions into the humus. The surface of these branches is covered with short unicellular hairs (paraphyses); rhizoids are absent. The antheridia and archegonia, which occur on the same prothallus, resemble those of *O. pedunculosum*.

Helminthostachys zeylanica. The wholly saprophytic prothalli of this plant occur about two inches below the surface of the ground. They are radially symmetrical; the lower vegetative half, in which is an endophytic fungus, is more or less lobed and bears rhizoids. The sexual organs are borne on the upper half; the antheridia are large and sunk beneath the surface; the archegonia project slightly from it. Sometimes the prothalli are monœcious, but more often a prothallus bears antheridia or archegonia only. The ternate lamina of the first leaf of the young plant is green and appears above ground.

Psilotum. A single prothallus, presumably belonging to this plant, was found embedded among the roots covering the stem of a tree-fern. It was one-quarter of an inch long and presented a general resemblance to some prothalli of *Lycopodium*, having a well-marked primary tubercle. The sexual organs were borne on the overhanging margin of the upper region of the prothallus, between which and the lower vegetative region the meristem will probably be found to be situated.

June 20.—"The Mechanism of the Electric Arc." By (Mrs.) Hertha Ayrton. Communicated by Prof. Perry, F.R.S.

The object of the paper is to show that, by applying the ordinary laws of resistance, of heating and cooling and of burning to the arc, considered as a gap in a circuit furnishing its own conductor by the volatilisation of its own material, all its principal phenomena can be accounted for, without the aid of a large back E.M.F., or of a "negative resistance," or of any other unusual attribute.

The Apparent Large Back E.M.F.

It is shown how volatilisation may begin, even without the self-induction to which the starting of an arc, when a circuit is broken, is usually attributed; and it is pointed out that, when the carbons are once separated, all the material in the gap cannot retain its high temperature. The air must cool some of it into carbon *mist* or *fog*, just as the steam issuing from a kettle is cooled into water mist at a short distance from its mouth. The dissimilar action of the poles common to so many electric phenomena displays itself in the arc at this point. Instead of *both* poles volatilising the *positive* pole alone does. It is considered, therefore, that the arc consists of (1) a thin layer of carbon vapour issuing from the end of the positive carbon, (2) a bulb of carbon mist joining this to the negative carbon, and (3) a sheath of burning gases, formed by the burning of the mist, and the hot ends of the carbons, and surrounding both. The vapour appears to be indicated in images of the arc by a sort of gap between the arc and the positive carbon, the mist by a purple bulb and the gases by a green flame.

The flame is found to be practically insulating, so that nearly the whole of the current flows through the vapour and mist alone. It is suggested that the vapour has a high specific resistance compared with that of the mist, and that it is to the great resistance of this vapour-film that the high temperature of the crater is due, and not to any large back E.M.F. of which it is the seat.

Volatilisation can only take place at the surface of contact between the vapour-film and the positive carbon. When that surface is smaller than the cross-section of the end of the carbon it must dig down into the solid carbon and make a pit. The sides of the pit, however, must be hot enough to burn away where the air reaches them, hence there is a race between the volatilisation of the centre of the carbon and the burning of its sides that determines the shape of the carbon. When the arc is short, the air cannot get so easily to the sides of the pit, hence it remains concave. When the arc is long, the burning of the sides gains over the volatilisation of the centre, and the surface of volatilisation becomes flat, or even slightly convex.

The peculiar shaping of the negative carbon is shown to be due to its tip being protected from the air by the mist and its sides being burnt away under the double action of radiation from the vapour film and conduction from the mist, to a greater or less distance, according to the length of the arc and the cross-section of the vapour-film.

It is shown that if the crater be defined as being that part of the positive carbon that is far brighter than the rest, then the crater must be larger, with the same current, the longer the arc, although the area of the volatilising surface is *constant* for a constant current.

By considering how the cross-section of the vapour-film must vary with the current and the length of the arc, it is found that its resistance f must be given by the formula

$$f = \frac{h}{A} + \frac{k+ml}{A^2},$$

where h, k and m are constants, l is the length of the arc, and A the current. This is the same form as was found by measuring the P.D. between the positive carbon and the arc by means of an exploring carbon and dividing the results by the corresponding currents. Hence the existence of a thin film of high-resisting vapour in contact with the crater would not only cause a large fall of potential between the positive carbon and the arc, exactly as if the crater were the seat of a large back E.M.F., but it would cause that P.D. to vary with the current and the length of the arc exactly as it has been found to vary by actual measurement.

The Apparent "Negative Resistance."

As nearly all the current flows through the vapour and mist, the surrounding flame being practically an insulator, the resistance of a solid carbon arc, apart from that of the vapour, must depend entirely on the cross-section of the mist. To see how this varies with the current, images of an arc of 2 mm. were drawn, with the purple part—the mist—very carefully defined, for currents of 4, 6, 8, 10, 12 and 14 amperes. The mean cross-section of the mist was found to increase more rapidly than the current, consequently its resistance diminishes more rapidly than the current increases. As the formula for the resistance of the vapour film shows that it too diminishes faster than the current increases, it follows that the whole resistance of the arc does the same, and that consequently the P.D. must diminish as the current increases. Hence if δV and δA be corresponding increments of P.D. and current, $\delta V/\delta A$ must be negative, although the resistance of the arc is positive.

It is found, from the above measurements of the cross-sections of the mist, that the connection between m, the resistance of the mist, and the current, is of the form,

$$m = \frac{\alpha}{A} + \frac{\beta}{A^2}.$$

If m varies directly with the length of the arc, then

$$m = \left(\frac{\alpha}{A} + \frac{\beta}{A^2}\right) l.$$

Adding this equation to (1), we get

$$f + m = r = \frac{p+ql}{A} + \frac{s+tl}{A^2}$$

for the whole resistance of the arc, which is exactly the form that was found by dividing direct measurements of the P.D. between the carbons by the corresponding currents. Hence there is no reason why this ratio should not represent the *true* resistance of the arc.

Under what circumstances $\delta V/\delta A$ *measures the True Resistance of the Arc.*

When the current is changed it takes some time for the vapour film to alter its area to its fullest extent, and still more time for the carbon ends to change their shapes. All the time these changes are going on the resistance of the arc, and, consequently, the P.D. between the carbons, must be altering also. Both these, therefore, depend, not only on the current and the length of the arc, but also, till everything has become steady again, *i.e.* till the arc is "normal" again, on how lately a change has been made in either. At the first instant after a change of current, before the volatilising area has had time to alter at all, δV and δA must have the same sign, just as they would if the arc were a wire, but as the volatilising surface alters, the sign of δV changes. If, therefore, a small alternating current is applied to the direct current of an arc, it will depend on the frequency of that current whether $\delta V/\delta A$ is positive or negative. When the frequency is so high that the volatilising surface never changes at all, $\delta V/\delta A$ will measure the true resistance of the arc unless it has a back E.M.F. which varies with the alternating current.

The measurements of the true resistance of the arc made in this way by various experimenters have given very various results, because probably the frequency of the alternating currents employed has been too low not to alter the resistance of the arc. A curve is drawn showing how the value of $\delta V/\delta A$ with the same direct current and length of arc varies with the frequency of the alternating current, and it is pointed out that even if the arc has as large a back E.M.F. as is usually supposed, the *true* resistance cannot be measured with an alternating current of lower frequency than 7000 complete alternations per second.

The exact conditions under which the *true* resistance of the arc can be measured in this way are examined, and the precautions that it is necessary to take to ensure the fulfilment of these conditions are enumerated.

The Changes introduced into the Resistance of the Arc by the Use of Cored Carbons.

A core in either or both carbons has a great effect on both the P.D between the carbons and the *change* of P.D. that accompanies a given *change* current. It lowers the first and makes the second more positive, *i.e.* gives it a smaller negative or larger positive value, as the case may be. It is pointed out that this might be due to the influence of cores either on the cross-section of the arc or on its specific resistance, or on both.

To see the effect on the cross-section, enlarged images were drawn of 2 mm. arcs with currents increasing by 2 amperes from 2 to 14 amperes, between four pairs of carbons, + solid − solid, + solid − cored, + cored − solid, + cored − cored. Two sets of images were drawn with each pair of carbons—the one immediately after a change of current, to get the "non-normal" change, and the other after the arc had become normal again. The mean cross-section of the mist was calculated in each case, and its cross-section where it touched the crater was taken to be a rough measure of the cross-section of the vapour film.

It was found that the mean cross-section of the mist with a given current was largest when both carbons were solid, less when the negative carbon alone was cored, less still when the positive alone was cored, and least when both were cored. Coring either the positive carbon alone, or both carbons, had the same effect on the cross-section of the vapour film as on that of the mist, but coring the negative alone only diminished this cross-section immediately after a change of current, but not when the arc had become normal again. Hence it was deduced that if the cores altered the *cross-sections* of the arc only they would *increase* its resistance, and, consequently, the P.D. between the carbons. As they *lower* this, however, they must do it by lowering the specific resistance of the arc more than they increase its cross-section. The vapour and mist of the core must therefore have lower specific resistances than the vapour and mist of the solid carbon.

When it is the positive carbon that is cored, all the vapour and mist come from the *cored* carbon. When the negative, they come from the *uncored* carbon, and it is only because the metallic salts in the core have a lower temperature of volatilisation than carbon that the mist is able to volatilise these and so lower its own specific resistance.

The effect of a core in either carbon, or in both, must depend on the current, because the larger the current the more solid carbon will the volatilising surface cover, and the less, therefore, will the specific resistances of the mist and vapour be lowered. The way in which the core acts in each case is traced, and the alterations in the specific resistances and cross-sections due to the core are shown to bring about changes in the P.D. exactly similar to those found by actual measurements of the P.D. between the carbons. It is shown, for instance, how these changes entirely account for the fact established by Prof. Ayrton (Electrical Congress at Chicago, 1893) that, with a constant length of arc, while the P.D. diminishes continuously as the current increases, when both carbons are solid, it sometimes remains constant over a wide range of current, or even increases again, after having diminished, when the positive carbon is cored.

The alterations in the value of $\delta V/\delta A$ introduced by the cores are next discussed, and it is shown that the changes in the resistance of the arcs that *must* follow the observed changes in its cross-section, coupled with the alterations that must ensue from the lowering of its specific resistance, would modify $\delta V/\delta A$ just in the way that Messrs. Frith and Rodgers ("The Resistance of the Electric Arc," *Phil. Mag.* 1896, vol. xlii. p. 407) found that it was modified by direct measurement. Thus all the principal phenomena of the arc, with cored and with solid carbons alike, may be attributable to such variations in the specific resistances of the materials in the gap as it has been shown *must* exist, together with the variations in the cross-sections of the arc that have been observed to take place. Hence it is superfluous to imagine either a large back E.M.F. or a "negative resistance."

"The Nature and Origin of the Poison oι *Lotus arabicus*." By Wyndham R. Dunstan, M.A., F.R.S., Director of the Scientific and Technical Department of the Imperial Institute, and T. A. Henry, B.Sc., Salters' Company's Research Fellow in the Laboratories of the Imperial Institute.

The authors have already given a preliminary account (*Roy. Soc. Proc.*, vol. lxvii. p. 224, 1900) of this investigation and have shown that the poisonous property of this Egyptian vetch is due to the prussic acid which is formed when the plant is crushed with water, owing to the hydrolytic action of an enzyme, *lotase*, on a glucoside, *lotusin*, which is broken up into hydrocyanic acid, dextrose and lotoflavin, a yellow colouring matter.

The authors have continued the investigation with the object of ascertaining the properties and chemical constitution of lotoflavin and of lotusin, and also of studying the properties of lotase in relation to those of other hydrolytic enzymes.

Lotusin.

Lotusin can be separated from an alcoholic extract of the plant by a tedious process giving a very small yield, about 0·025 per cent.

Lotusin is a yellow crystalline glucoside, more soluble in alcohol than in water. When heated it gradually decomposes without exhibiting any fixed melting point. Combustions of specially purified material gave numbers agreeing with those deduced from the formula $C_{28}H_{31}NO_{16}$.

In the preliminary notice the formula $C_{22}H_{19}NO_{10}$ was provisionally assigned to lotusin on the assumption that one molecule of dextrose is formed by its hydrolysis. The formula given above, as the result of ultimate analysis, is confirmed by the observation that two molecules of dextrose are produced by acid hydrolysis, which is therefore represented by the equation—

$$\underset{\text{Lotusin.}}{C_{23}H_{31}NO_{16}} + 2H_2O = \underset{\text{Dextrose.}}{2C_6H_{12}O_6} + \underset{\text{Prussic acid.}}{HCN} + \underset{\text{Lotoflavin.}}{C_{15}H_{10}O_6}.$$

When a solution or lotusin is warmed with dilute hydrochloric acid, hydrolysis readily occurs. The liquid acquires a strong odour of hydrocyanic acid and a yellow crystalline precipitate of lotoflavin is thrown down, whilst the solution strongly reduces Fehling's solution. Dilute sulphuric acid only very slowly effects the hydrolysis of lotusin.

When warmed with aqueous alkalis, lotusin is gradually decomposed, ammonia being evolved and an acid formed to which the name *lotusinic acid* has been given.

$$C_{28}H_{31}O_{16} + 2H_2O = C_{29}H_{32}O_{18} + NH_3.$$

Lotusinic acid is a monobasic acid furnishing yellow crystalline salts. It is readily hydrolysed by dilute acids forming latoflavin, dextrose and heptogluconic acid (dextrose-carboxylic acid):

$$\underset{\text{Lotusinic acid.}}{C_{28}H_{32}O_{18}} + 2H_2O = \underset{\text{Lotoflavin.}}{C_{15}H_{10}O_6} + \underset{\text{Dextrose.}}{C_6H_{12}O_6} + \underset{\text{Heptogluconic acid.}}{C_7H_{14}O_8}.$$

With the exception of amygdalin, lotusin is the only glucoside definitely known which furnishes prussic acid as a decomposition product.

Lotoflavin.

Lotoflavin is a yellow crystalline colouring matter readily dissolved by alcohol or by hot glacial acetic acid, and also by aqueous alkalis forming bright yellow solutions. It is always present to some extent in the plants, especially in old plants. Ultimate analysis leads to the formula $C_{15}H_{10}O_6$. It is therefore isomeric with luteolin, the yellow colouring matter of *Reseda luteola*, and with *fisetin*, the yellow colouring from young fustic, *Rhus cotinus*. *Morin*, from *Morus tinctoria*, appears to be hydroxylotoflavin.

Lotoflavin does not form compounds with mineral acids. It furnishes a tetracetyl derivative and two isomeric mutually convertible trimethyl ethers which are capable of forming one and the same acetyl-trimethyl-lotoflavin. By the action of fused potash lotoflavin is converted into phloroglucin and β-resorcylic acid.

Dextrose.

The sugar resulting from hydrolysis has been found to correspond in all properties with ordinary dextrose.

Hydrocyanic acid.

The amount of prussic acid given by plants at different stages of growth has been ascertained. Mature plants bearing seed-pods have furnished 0·345 per cent. of this acid, calculated on the air-dried material which corresponds with 5·23 per cent. of lotusin. Younger plants bearing flower buds gave 0·25 per cent., whilst still smaller quantities were furnished by very young plants and hardly any by quite old plants from which the seeds had fallen.

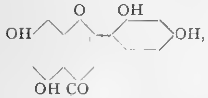
The formation of the poison, therefore, seems to reach its maximum at about the seeding period, and after this period to diminish rapidly. The Arabs are aware that the plant is safe to use as a fodder when the seeds are quite ripe, but not before. We have found that it is the lotusin which disappears during the ripening of the seeds. Old plants contain some lotase and lotoflavin, but little or no lotusin.

Lotase.

In its general properties lotase resembles other hydrolytic enzymes, from which, however, it differs in several important respects. It may be compared with emulsin, the enzyme of bitter almonds. Emulsin, however, only attacks lotusin very slowly, whilst lotase has but a feeble action on amygdalin, the glucoside of bitter almonds. Lotase is much more readily injured and deprived of its hydrolytic power than emulsin. On this account it is difficult to isolate in the solid state. Its power is not only rapidly abolished by heat, but is also gradually destroyed by contact with alcohol or glycerine. Besides lotase, the plant contains an amylolytic and a proteolytic enzyme.

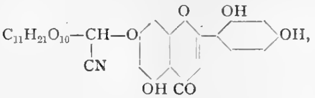
Constitution of Lotoflavin and Lotusin.

Having regard to its reactions and especially to the production, by the action of fused alkali, of β-resorcylic acid and phloroglucin, the authors conclude that lotoflavin should be represented by the formula



which is that of a compound belonging to the same class, of phenylated pheno-γ-pyrones, as its isomerides luteolin and fisetin. The peculiarity shown by lotoflavin of containing four hydroxyl groups, but furnishing only a *tri*methyl ether, is accounted for by one of the hydroxyl groups being in the ortho position to a carbonyl group.

The reactions of lotusin are best represented by the formula :



which is that of a lotoflavin ether of maltose-cyanhydrin.

This formula satisfactorily accounts for the partial hydrolysis of the glucoside by alkalis giving lotusinic acid and ammonia, and for the decomposition of the substance by acids giving lotoflavin and maltose-carboxylic acid, which is immediately decomposed into dextrose and heptogluconic acid. It also accounts for the hydrolysis of lotusin, by acids, into lotoflavin and maltose, which is further changed to dextrose.

In order to definitely localise the position of the cyanogen group in lotusin, the behaviour of several cyanhydrins of known constitution have been examined with reference to the question as to whether they would furnish hydrocyanic acid when acted on by dilute hydrochloric acid. It was found that mandelic nitrile, lævulose cyanhydrin and pentacetyl gluconitrile, in which the cyanogen group is known to occupy a position similar to that assumed for it in the formula suggested for lotusin, are, like lotusin, easily decomposed by dilute hydrochloric acid forming prussic acid and the corresponding aldehyde or ketone.

The authors wish again to express their obligations to Mr. Ernest A. Floyer, of Cairo, Member of the Egyptian Institute, who has spared neither trouble nor expense in collecting in Egypt, and despatching to this country, the material required for this investigation.

PARIS.

Academy of Sciences, July 29.—M. Fouqué in the chair.—On the cooling power of a gaseous or liquid current, by M. J. Boussinesq.—On the variation in luminosity of the planet Eros; duration of the period, by M. Ch. André. As the mean result of a series of measurements carried out by three independent observers at the observatory of Lyons, the period between two consecutive minima is found to be 5h. 16m. 15·2s. It was found that the observations of the minima could be more accurately made than those of the maxima.—On surfaces susceptible of a continuous deformation with conservation of a conjugated system, by M. A. Demoulin.—On the analytical integrals of differential equations of the first order and of any degree in the neighbourhood of certain singular values, by M. Henri Dulac.—On the infinitely small deformation of an elastic body submitted to known forces, by MM. Eugène and François Cosserat.—On the vibrations of liquid films of determinate forms, by MM. Chéneveau and G. Cartaud. An experimental study by a photographic method of the wave figures produced on the surface of liquids contained in vessels of different forms.—On the radio-activity of radium salts, by MM. P. Curie and A. Debierne. A study of the conditions under which a radio-active salt can impart active properties to water. A solution of a radium salt exposed in an open vessel steadily loses its active properties, the rate of loss being proportional to the surface exposed to the air. But if this solution is kept in a sealed tube it gradually acquires its original activity.—A geographical demonstration of the terrestrial origin of the polar aurora, by M. Henri Stassano. All the facts cited are in accord with the theory of De la Rive.—On the continuity of the spectra due to solids and to incandescent liquids, by M. L. Décombe.—On the electrocapillary action of molecules not dissociated into ions, by M. Gouy.—On the solubility of mixtures of sulphate of copper and sulphate of soda, by MM. Massol and Maldès. Solutions obtained with a mixture of the sulphates of soda and copper, the two salts being in excess, possess an invariable composition at ordinary temperatures, but if the temperatures are sufficiently high to produce the anhydrous modification of sodium sulphate, the composition of the solution varies with the relative proportion of the two salts present.—On the chloride of neo-didymium, by M. Camille Matignon. Details are given of a simple method of preparation of the anhydrous chloride, and also of a new hydrate.—Study of the alloys of aluminium and molybdenum, by M. Leon Guillet. The reduction of molybdic acid by aluminium gives rise to no less than six compounds corresponding to the formulæ Al_7Mo, Al_3Mo, Al_2Mo, AlMo, $AlMo_4$, and a compound very rich in molybdenum, perhaps $AlMo_{20}$.—The crystallisation of cerium oxide, by M. Jean Sterba. The crystallisation of cerium oxide can be effected from sodium chloride, borax and potassium sulphate. It forms cubes or octahedra which are colourless and transparent.—Contribution to the study of cæsium, by M. C. Chabrié. A description of the sulphites and hyposulphites of cerium.—On the pyrogallol sulphonic acids, by M. Marcel Delage.—The action of ethyl alcohol upon barium ethylate. The synthesis of normal butyl alcohol, by M. Marcel Guerbet. By heating a strong solution of barium ethylate in ethyl alcohol in a sealed tube at 240° C., a small quantity of normal butyl alcohol is produced along with ethylene and hydrogen.—On the composition of the albumen of the seed of *Phoenix canariensis* and on the chemical phenomena which accompany the germination of this seed, by MM. É. Bourquelot and H. Herissey.—On the histological constitution of the retina in congenital absence of the brain, by MM. N. Vaschide and Cl. Vurpas.—Cultures and attenuated forms of the cryptogamic diseases of plants, by M. Julien Ray.—On the affinity of the red corpuscles of the blood for acids and alkalis and on the variations of resistance which they impress upon these reagents towards solanine, by M. E. Hédon.—On the nitrogenous nutrition of yeast, by M. Pierre Thomas.—The influence of lecithin upon the nutritive exchanges, by M. G. Carriere.

CONTENTS.

THURSDAY, AUGUST 15, 1901.

MIALL AND FOWLER'S "SELBORNE."

The Natural History and Antiquities of Selborne. By Gilbert White. Edited, with an Introduction and Notes, by L. C. Miall, F.R.S., and W. Warde Fowler, M.A. Pp. xl + 386. (London: Methuen, 1901.) Price 6*s.*

ECCE ITERUM! It is little over six months since the "painful" Mr. Sherborn compiled a bibliography of Gilbert White's matchless work, enumerating some 115 editions or issues of it, and here in England at least three more have since made their appearance, while we hear of another in America—to say nothing of the "Life and Letters" of the author now first fully given to light and recently reviewed in these columns (NATURE, July 18, 1901, p. 276)! Still, the edition of the evergreen classic, "Natural History and Antiquities of Selborne," with introduction and notes by Prof. Miall and Mr. Warde Fowler, deserves consideration here, for though these gentlemen have judiciously availed themselves of the labours of some of their predecessors in the art editorial and commentarial, they have added a good many notes of their own, not a few possessing a quite original character, while their introduction is of itself well worth reading.

Messrs. Miall and Fowler were, of course, too early to profit by Mr. Holt-White's biography of his great-grand-uncle, for their publication followed his by only a few weeks, and they must regret that this is so, since they depended for the most part on the statements of the late Prof. Bell, and naturally fell into his mistakes. From some of the worst of them, it is true, they might have saved themselves had they studied, instead of being content to mention, the memoir of Gilbert White which appeared more than eighteen months ago in the "Dictionary of National Biography"; but they seem, like most persons, to have supposed that an article in a dictionary is only for reference and not for reading. It may be said that, except in one case, their errors are of comparatively slight importance; but they have perpetuated the modern Oxford slander—now proved to be founded on imperfect acquaintance with the facts—that White was unpopular in his college and only held his fellowship there by holding his tongue, the sole ground of this imputation being two or three private memorandums of the then Provost of Oriel, who was temporarily smarting from a contested election in which White had been his rival. The two men had previously been friends, and it is satisfactory to know that friends they became again when the acrimony engendered by the competition had passed off. The worst of this mud having been thrown is that some of it will stick; but it behoves every member of that distinguished college—nay, every Oxford man—to do his best to wipe away this unfounded aspersion on White's fair fame. Mr. Fowler himself, we doubt not, must feel sorry that he has helped to spread this baseless accusation.

But our business here is not with White's book or life or character more than as they are dealt with by his present editors. With much of what Prof. Miall says we cordially agree, but when he writes that "White was a man of few books and of no great range of thought" we wholly dissent. It may be that he could not read French—easily at least—few Oxford clerics of his day could; but he certainly did know what Buffon was about, and Hérissant also, for he criticises both; and if he did not name Leeuwenhoek (who wrote in English, by the way) or Malpighi, why, we may ask, should he do so? Undoubtedly John Hunter was then dissecting, but for the most part of his life he was known to few as being more than a skilful surgeon, and what was there in the six or eight papers he had then published to call for White's notice of them? Prof. Miall remarks that "all the books which were essential to the 'Natural History of Selborne' would have gone into a single shelf." That is a mistake: the book of Nature is not to be shelved, and therein lay White's chief study. Again, we are told that he cared little for the British Museum or the Botanic Garden at Kew, and that Cook's voyages are not dwelt upon repeatedly and with interest. With all deference to Prof. Miall, such objections are futile. The collections then at the British Museum must have been extremely unimportant—the Museum of the time was the Leverian, which is repeatedly mentioned by White, and Kew Garden was the King's private affair, to which the public scarcely had access; but in Cook's voyages White plainly took very great interest, partly, no doubt, through his acquaintance with Banks, Cook's shipmate on the first of them. Reference to them is often made in his correspondence, though there was no need to bring it into his book. Surely Prof. Miall would justly resent being accused of indifference to the *Challenger's* voyage because we see no mention of it in the volume before us? We may charge him, however, with not having divested himself of the commonplace desire to fall foul of Pennant, who, he says, "was not enough of a zoologist to write books on zoology." This is amazing, for who then, we may ask, wrote the "British Zoology" (of which there were three editions and four issues in his lifetime), the "Indian Zoology" (two editions and a German translation), the "Arctic Zoology" (the same), to say nothing of the "History of Quadrupeds" and other works? It may be urged that in these labours he had assistance, and that some classes of animals met with scant treatment; but when has such not been the case? and in what other country were contemporary zoologies of similar character published with the same wealth of illustration? Prof. Miall admits that he was the best-known English zoologist of his day, and if in the later issues of the "British Zoology" his acknowledgment of White's aid was general rather than particular, is not the fact directly due to the latter having corrected, as he himself says he did, the former's proofs, when he naturally did not insert passages in his own favour? Unless Pennant in his own "Life" is guilty of positive misstatement, which there is not the least reason to believe, he expended very considerable sums in the illustration of his several works, and when he paid for the plates he reasonably thought he had some right to use them. This, we take it, was the cause of the misunderstanding, for it seems to have been nothing more, between him and John White in regard to illustrations for the latter's "Fauna Calpensis," which, unfortunately, was never published. It was natural for Gilbert White at first to take his brother's side and grumble at Pennant; but it would seem almost certain that explanations must have followed, and with them the discontent ceased. To us Pennant's influence on Gilbert White appears to have been distinctly advantageous, just as that of Barrington was the converse. No one can study Pennant's works without seeing that he was full of great ideas—whether they were original or not does not signify for our present purpose—and they were in the main true,[1] whereas Barrington's views seem to be always based on some prejudice or foregone conclusion, to support which he brought his very considerable forensic power to bear, and in the majority of cases arrived at an erroneous conclusion—take his ingenious argument as to the origin of the turkey, for example—and, though undoubtedly in many respects a benefactor, he was apparently White's evil genius in continually urging his absurd belief in the torpidity of the swallow-kind.

This remark brings us to Mr. Fowler's part of the introduction, in which he tries to account for White's astonishing adhesion to that belief, and his readiness to grasp at any scrap of information which seemed to support it, in spite of his own failure to discover a particle of evidence in its favour, and the fact that he fully accepted migration in the "short-winged birds" while doubting it in those that possessed far superior power of flight. Mr. Fowler's mode of accounting for White's "loyalty to an old delusion" seems hardly adequate, yet we must confess our inability to offer a suggestion that satisfies ourselves. We can hardly think that Aristotle, great as we admit was his authority in the Middle Ages, was responsible for the misconception, or even Olaus Magnus—much less Carew. They only repeated the stories of the vulgar and unreflective, and how Willughby's language on the subject "served to perpetuate the tradition" (as Mr. Fowler maintains it did) is more than we can understand. The whole thing is inexplicable, and is really the one flaw in White's reputation as a reasoning naturalist. Though in his earliest letter to Pennant (printed as No. x.) he frankly says that no account of swallows being found torpid in Hampshire is worth attention, the two instances he immediately cites—on the authority of "a clergyman of an inquisitive turn" and of "another intelligent person," each of them being in his boyhood—must have greatly influenced him. He can hardly be said to have been credulous on the subject. He simply thought that the evidence in favour of torpidity, though not satisfying, was such as ought to be tested, and he would no doubt have been pleased to obtain confirmation of it. In this respect he was like many people in our own day who engage in psychical research. Spirits refuse to come at their call from the vasty deep or boundless space, and search as he might, and did, amid the shrubs of Selborne Hanger or under the roofs of his neighbours' cottages, nor swift nor swallow would show itself.

Taken as a whole, the notes to this edition are very good, and those by Prof. Miall on the geology of the district are most acceptable, for few, if any, of White's recent editors have touched upon that subject. Those by Mr. Fowler on ornithology are for the most part extremely effective, whether culled from his predecessors or added from his own experience, and though he does suggest (p. 35) that the bird "so desultory" in its flight, at which White shot in vain, was a siskin and not a chiff-chaff, and (p. 83) would seem to consider the motion of the redstart's tail open to doubt, we have no such impossible suppositions as are found elsewhere to the effect that White did not know a crow from a rook, or the song of the wryneck from the cry of the pied woodpecker. If the introduction could be but freed from the blemishes we have here noticed, and a few more beside, this edition of the "Natural History and Antiquities of Selborne" might be recommended as one of the most accurate, as it is one of the neatest and most handy.

[1] The often-quoted case of the herring migration must, of course, be excepted, but therein he was misled by the reports of fishermen whom he trusted.

THE ORIGIN OF EUROPEAN PEOPLES.

The Mediterranean Race: a Study of the Origin of European Peoples. By G. Sergi. Pp 320; 93 illustrations in the text. The Contemporary Science Series. (London: Walter Scott, 1901.) Price 6*s.*

THE problem of our origins must always prove an interesting subject for research; speculation has found it only too fertile a prey. At the present state of our knowledge fresh information is being amassed continually, so that the field for speculation is, fortunately, becoming more narrowed. A recent contribution to the problem is from the enthusiastic Italian anthropologist, Prof. G. Sergi, of Rome, who has published in English an entirely new book, based on his "Origine e diffusione della stirpe Mediterranea," 1895. Those who are acquainted with the previous writings of Prof. Sergi will quite know what to expect in this new volume. The familiar arguments and data are reinforced by additional facts, and the author's conclusions are clearly and definitely stated. The following is the position he has adopted in this book, and which we may take as the expression of his matured views.

Homo Neanderthalensis is a distinct European species, which includes the Spy type and which originated in Europe in early Quaternary or possibly late Tertiary times. Hitherto it has not been found south of the Alps, and it has not completely disappeared from Europe, but persists in the Baltic, in Friesland and elsewhere.

The Chancelade, Laugerie-Basse, Baumes-Chaudes, Cro-Magnon crania constitute a group that extended from the Upper Quaternary into early Neolithic times. The view of Hervé and other French anthropologists is that this was a hyperborean stock that migrated from north to south as far as Africa, but excluding Egypt and the Canary Islands. Sergi shows that all the characteristics of the Chancelade skull are found in typical Mediterranean crania; indeed, he defines it as

"a *Pelasgicus stegoides* of the *Ellipsoides* class, still found to-day in East Africa. Why refer to the Eskimo, a skull to be found so near as the Mediterranean?" (p. 195).

The other cranial types are admittedly quite Mediterranean in character. If Scandinavia was not inhabited before the Neolithic period and northern Europe could not be inhabited by man until after the Glacial epoch, it is not easy to see how the centre and south of Europe could be invaded by a race originating in the north in the Quaternary epoch (p. 199).

The Neolithic dolichocephals, according to Sergi, were a northern migration of a group of *Homo Eurafricana*. This species may be divided into three races :—

"The *African*, with red-brown and black pigmentation ; the *Mediterranean*, of brunet complexion ; a *Nordic* race, of blond skin and hair, blue or grey eyes" (p. 259).

The Hamitic race never invaded Europe. In the late Quaternary epoch immigrations of the Eurafrican species took place from Africa into Europe. On the mainland of northern Europe a distinct differentiation took place so far as stature and pigmentation were concerned, but the cranial and facial forms were practically unaltered, and the Reihengräber type of the Germans and the Viking type of the Scandinavians were evolved. On pp. 252–255 the author discusses the obvious objections to this view. The whole of the Mediterranean basin, western Europe and the British Islands were inhabited by the brunet race.

The problem of the African blonds is fully discussed (pp. 59–83) by Prof. Sergi. After stating the views of various investigators, he says,

"It seems to me impossible to find in the blonds of Africa a racial element from northern Europe. If they had come at so early a period (in the times recorded by the Egyptian monuments) they would have radically modified Libyan civilisation beginning with funeral customs and imposed their own language" (p. 72).

In their "Libyan Notes" (1901), Messrs. D. Randall-Maciver and A. Wilkin state that the Berbers of Algeria are always a white-skinned people, and about ten per cent. are blond or fair-haired. Sergi is satisfied that the differences in colour of hair, skin and eyes between the darker and the lighter people are due to the influence of altitude, as the Atlas chain is the headquarters of the blonds in Morocco, and he regards these mountains as the centre of formation of the blond element in North Africa.

Neither of the European races of the Eurafrican species has anything in common with the so-called Aryan races. Sergi holds that it is an error to maintain that the Germans and the Scandinavians, blond dolichocephals, are Aryans. The Aryans are of Asiatic origin, and constitute a variety of the Eurasiatic species.

The anthropological unity of Europe, existing from the late Quaternary epoch and greatly increased during Neolithic times, was broken, at first peacefully and to but a slight extent, and afterwards violently, by a new species coming from Asia. Even in Neolithic times the advance guard of the wave of migration of the brachycephalic *Homo Eurasica* had penetrated slowly and peacefully into France. But then they began to come in larger and hence more turbulent bodies, and caused many changes. These invaders were savages inferior to the Neolithic Europeans, whose civilisation they in large part destroyed, replunging Europe into barbarism, also introducing the new burial custom of cremation, together with other customs, and transforming the existing languages into their own, which was a flexional language. To-day this new anthropological family, which also constitutes a zoological unit, bears three chief names, indicating three characteristic linguistic groups—Celts, Germans, Slavs. The skull of this species shows four primary forms—cuboid, cuneiform or sphenoid, spheroid and platycephalic—all corresponding to broad, brachycephalic skulls which contrast with the pentagonal, ellipsoidal, ovoid and arrow-shaped (beloides) cranial varieties of the Eurafrican species.

Wherever the Mediterranean stock established itself it preserved its primitive burial custom of inhumation and the characteristic architecture of the chambered tomb. This varies from the natural and artificial grottoes of the Mediterranean region to nurags, pyramids, dolmens and tumuli. Sergi has previously expressed the opinion that the prehistoric artists of the French caves, who possessed such developed artistic feeling, were the precursors of the historical artists who created the marvellous works of Egypt, Greece and Rome ; but he strongly holds the view that the Mycenæan or Ægean civilisation was largely of Asiatic origin, although he does not subscribe to the theory of Montelius that "the Mycenæan civilisation in Greece is due, not to an influence from another country, but to immigration of a new people." Sergi believes that the Asiatic immigrants, Pelasgo-Tyrrhenians and possibly others, were not anthropologically foreign to the Mediterranean stock. These, and the inhabitants of the Ægean Islands and the Peloponnesus, already possessed a pre-Mycenæan civilisation in common with the Afro-Mediterranean civilisation, but the new culture was the result of Asiatic influences, probably Mesopotamian and Hittite.

The introduction of bronze into Europe has been a fruitful subject for discussion. Sergi has given up the Celtic theory, and now believes that the importation of bronze was due to the Mediterraneo-Oriental culture.

The use of a script is so ancient that it had already reached definite shape in the Magdalenian epoch, that is to say earlier than the Neolithic times, as is proved by the painted pebbles in the cave of Mas d'Azil in the south of France ; and writing signs were widely diffused in countries peopled by the Mediterranean race in very ancient times. The languages of these peoples were also of Eurafrican origin, corresponding to the languages otherwise called Hamitic.

It is evident that this book bristles with debatable points, and we may look forward to interesting discussions from all quarters, as the intrepid Italian savant does not belong to any one school of Continental thought. Doubtless Prof. Ridgeway, for one, will have something to say to Prof. Sergi when the second volume of his "Early Age of Greece" is published. A. C. H.

A MECHANISM FOR THE TRANSMISSION OF STIMULI IN PLANTS.

Die Reizleitung und die reizleitenden Strukturen bei den Pflanzen. Von Dr. B. Nemec. Mit 3 tafeln und 10 abbild. im Text. Pp. 153. (Jena : Verlag von Gustav Fischer, 1901.) Price Mk. 7.

IT has long been known that certain parts of many plants are capable of being irritated by appropriate means, and that the stimulus thus perceived is in some way transmitted through an intervening quiescent region to a spot or zone at which it is translated into a definite motile reaction. But it has also been constantly denied that there exists in plants anything comparable to the nervous system of animals; and the transmission of the stimulus has commonly been referred either to a serially altered condition of the protoplasm in its relation to water, or to vague suggestions arising from the well-known facts of protoplasmic continuity between adjacent cells, the onus of transmission being cast on the protoplasm as a whole.

Dr. Němec, however, contends that these notions demand reconsideration, and he gives an account in the book before us of observations which, if confirmed by subsequent examination, are of great importance as enabling us to obtain a more definite comprehension of the relations existing between perception and reaction in the motile organs of plants.

The author begins by studying the effects on the protoplasm of wounding the sensitive regions of roots and other organs, and, in the main, he confirms, and at the same time extends, the conclusions arrived at by Tangl some years ago. He distinguishes two traumatic phases as consequent on such an operation. The first, or *primary*, response consists in an aggregation of the protoplasm, and it may be of the nucleus also, to the wound-ward end of the cell. This effect is propagated with diminishing rapidity in a direction away from the wound, and at a rate which is not equal for the different tissues composing the organ. A curious fact relating to the travelling onward of the effect is brought to light in connection with cells in which nuclear division is proceeding, for the disturbance appears to miss these cells, though it reappears immediately beyond them. Shortly after this primary manifestation has passed over a cell, recovery supervenes, only, however, to give place to a *secondary* phenomenon. The protoplasm of the cells in the vicinity of the wound assumes a more or less gelatinous character, and the vacuoles begin to undergo fusion. This secondary effect is, however, apparently rather local, and travels neither so far nor so fast as does the primary one. It may perhaps be questioned whether the latter is not, at least mainly, due to a disturbance of hydrostatic equilibrium in the cells consequent on the lesion of the organ, whilst the secondary change may possibly be associated with the febrile condition known to be induced by mechanical and other injuries. Further investigation of the phenomena by means, *e.g.*, of plasmolysing reagents might prove of interest.

Of more general importance than these results is the statement that the author has succeeded, by means of appropriate stains, in demonstrating a continuous fibrillar structure in the cytoplasm. These fibrillæ, which are figured as somewhat thick cords, traverse the cell chiefly in the longitudinal direction; and, although the point was not definitely settled, they appeared to connect with similar ones in the contiguous cells of a longitudinal series. They are not equally present in every kind of tissue, sometimes they occur in the cortex whilst in other cases they are most abundant in the plerome. They are almost always met with in sensitive and motile organs, to which also they appear to be almost exclusively confined, and Němec believes that they represent the means whereby stimuli are rendered transmissible. He finds that conditions which impair or abolish such transmission also affect the fibrillar structure. The latter may, indeed, be temporarily or permanently disorganised, and so long as this is the case the organ appears to be insensitive.

Němec himself considers some of the objections which may be urged against his view of the functions of the fibrils. Thus it might be argued that the same causes which result in a dislocation of the sensitive mechanism of an organ may also, and concomitantly, destroy the normal structural configuration of the protoplasm, but that it does not therefore follow that the two should necessarily stand in any causal connection with each other. The force of such an objection is, however, weakened by two observations made on roots. In *Vicia*, the fibrils are restricted to the axile cylinder (plerome) of the root. Now if the cortex be severed by an annular cut, after the disturbance which ensues as the result of the injury has passed away, the organ recovers the power of perceiving and transmitting stimuli; if, however, the plerome be cut through, by means of a needle, then the power of future response in the case of stimuli affecting the distal end will be found to have been finally lost. Again, it is known that the perception, by roots, of the stimulus given by gravity is limited to the actual growing point, whilst the motile region, in which the stimulus provokes a visible result, is situated at some distance behind it. If the tip of the root be cut away, the power of further response to the gravity-stimulus is thenceforth in abeyance pending the regeneration of the apex. Now in some instances it was observed that the power of response to the stimulus was not recovered even after the formation of the new growing point, but in every one of these cases further examination showed that the fibrillar continuity had not been properly restored. Hence the path of transmission between the percipient apex and the executive motile portion of the root still remained interrupted.

It is clear that Dr. Němec has opened up a promising field of investigation, and one which is no less important from the point of view of the plant world than from that of the lower animal organisms in which also no permanent nervous system is present. It is to be hoped that the observations may be thoroughly tested by physiological as well as by histological methods, a task which should be rendered the easier inasmuch as the structures can apparently be identified in the still living cells.

J. B. F.

AMERICAN AGRICULTURAL RESEARCHES.

Yearbook of the United States Department of Agriculture, 1900. Pp. 888. (Washington, D.C., 1901.)

THE bulky volume before us is as full of interest as its predecessors, and as profusely illustrated. Its contents are extremely various, for, as mentioned in the preface, there is not a single bureau, division or office of the Department that has not contributed to the present book. The reports occupy 633 pages. These are followed by an appendix of 231 pages, in which a great deal of statistical and miscellaneous information is brought together for the use of the farming community. We can only refer to a very few of the subjects discussed.

The report on the cultivation of Smyrna figs in California is full of interest of many kinds. For this fig to be brought to perfection, it is necessary that the flower should be fertilised by pollen from the wild fig, or caprifig. The pollen is conveyed by an insect, *Blastophaga grossorum*, which goes through its various stages of growth in the wild fig. It is the practice in Smyrna and other fig-growing countries to break off the fruits of the caprifig, and tie them to the limbs of the edible fig tree, at the time when the flower receptacles of the latter are in a suitable condition. The result is the production of figs far larger and finer than would be obtained without this operation. The American report gives a brief history of our knowledge on this subject, and a detailed account of the introduction of the Smyrna fig into California, the subsequent introduction of the caprifig, and the final successful introduction, after several failures of the insect, with details of the work done during the season of 1899, when the first crop of figs fully equal to the imported article was obtained. For the successful fertilisation of the Smyrna fig it is necessary that the caprifig should blossom at the same time as the Smyrna fig, and that the winged female insect should also at the same time be emerging from the galls containing the pupa. These adjustments are liable to be disturbed by variations in climate and season, and require careful study and skilled scientific superintendence if fig culture is to be successfully introduced into a new country.

The report on the cultivation of the date palm is also of great interest. A full account is given of the conditions under which the finest dates are produced in Algeria and the Sahara, and of the steps which have been taken to introduce the best varieties of the date palm into Arizona and other suitable climates in the United States. It is shown that the best varieties can only be introduced by means of offshoots, the plants grown from seed being very various in character. Different climates require the choice of different varieties. The tree has the great merit of flourishing in climates in which the summer is too hot and too dry to permit of ordinary cultivation; it flourishes even in soils impregnated with alkali salts, a condition frequently met with in dry climates. The report should be of considerable value to the Agricultural Department of our Indian Empire, where vast areas of waste alkali land are still waiting to be dealt with.

There is one more report, of special interest in connection with the present summer, of which we will briefly speak: its subject is hot waves, the conditions which produce them and their effect on agriculture. The continent of North America is at present admirably suited for the study of meteorological phenomena; the observers cover an immense area, and are all in telegraphic communication with the Central Weather Bureau at Washington. The report in question includes the study of three remarkable periods of heat, and is illustrated by maps showing the distribution of pressure and temperature over the continent during these periods. The first point that strikes one is the unsuitableness of the phrase "hot wave." The heat periods are, indeed, periods of stagnation in the atmosphere. The conditions appear to be similar in each instance which is discussed. There is an area of moderately high pressure in the subtropical region towards the south-east; an area of moderately low pressure in the northern central States, and a second area of high pressure on the west or north-west coast. These conditions are steadily maintained during the hot period. There is, of course, a slow flow of air from the subtropical, south-eastern area of high pressure to the central or north-central area of low pressure. The extreme temperatures occur between these two regions. The great heat is not simply due to air coming from a warm region; it is largely due to the clear sky affording full opportunity for the receipt of solar energy, and to the small radiation during the night from the earth's surface; the hot nights are, indeed, a striking feature of these periods. What is the cause of this absence of night radiation with an apparently clear sky? It appears to be due to the presence of a large quantity of transparent water vapour in the higher regions of the atmosphere, which allows the passage of solar radiation but forbids the return of the lower grade heat waves of terrestrial radiation.

R. WARINGTON.

SCHOOL HYGIENE.

School Hygiene. By Edward Shaw, Professor of the Institutes of Pedagogy, New York University. Pp. 260. (London: Macmillan and Co., Ltd., 1901.) 4*s.* 6*d.* net.

A Manual of School Hygiene. By E. W. Hope, M.D., Professor of Hygiene, University College, Liverpool, and E. A. Browne, F.R.C.S.E., Lecturer of Ophthalmology, University College, Liverpool. Pp. 207. (Cambridge: University Press, 1901.) 3*s.* 6*d.* net.

IT has been the aim of the authors of these two works to set forth the conditions which should surround school pupils in order that their mental and physical health may be promoted. No true education in mental training can overlook the hygienic and physical relationship of mind and body, and no knowledge must be conveyed at the expense of physical and moral development; for it is true, as Mr. Herbert Spencer has reminded us, that the essential object of education is to teach us how to live happily. Moreover, the connection between physical health and the power of voluntary control and, consequently, of conduct, is very close, and perfect mental development cannot be brought about if the opportunity is not given for healthy physical development. Notwithstanding the general acceptance of these truisms, school buildings are still being erected with a view mainly to exterior effect, and an adequate system of ventilation in the crowded class-rooms is rarely to be met with. As Prof. Shaw has pointed out, the school-room should be the unit first to be considered in planning the school building, and the building should be a number of school-rooms properly disposed, and not a whole cut up into school-rooms whose size and arrangement are dependent upon the size and shape of the building.

The guiding principles of hygiene, so far as it is affected by the circumstances of school life, are well and clearly set forth in both books, and the essential facts of school health are brought within the easy reach of the parent or teacher. To do their duty in this respect, no great amount of detail knowledge is necessary, but rather one of general principles combined with an intelligent observation of children with the view of detecting those influences which tend to do harm. Many details in the practical work of the school are of the greatest hygienic importance, and these can only be directed by the teacher, who should recognise that it is the first duty of an educational system to promote good health among the scholars, and, indeed, that the success of any particular school is reflected in the physical health of those attending it as well as in their mental attainments.

"A Manual of School Hygiene" consists of two parts. In Part i., written by Prof. E. W. Hope, there are chapters upon site and soil, the school building, air, ventilation and warming, food and clothing, sickness, the personal aspect of infection, accidents and emergencies. Part ii. is written by Mr. E. A. Browne, and deals with the care of the eye, school furniture and writing, the air passages, exercise, over-pressure and the general management of health. The subjects of Part i. are not always treated with sufficient detail to meet the purposes of an elementary text-book. For instance, it is not sufficient to state that "other simple inlets for fresh air may be mentioned, such as Tobin's tubes, Louvres, Sherringham valves, Cooper's discs, &c." (p. 33); and again, that house drains "should be laid at such an inclination as will secure a velocity of not less than three feet per second, and the diameter should be four or six inches in accordance with the number of lavatories discharging into it" (p. 10). Many other instances could be quoted in which the matter given will convey little real information to one who already knows little or nothing of the subject. Owing to a hasty revision of the proof sheets, the carbonic acid of the general atmosphere is given as 0·4 per cent. on p. 16.

The treatment of the subjects of Part ii. is wholly excellent; the matter is scientifically sound, clearly written and sufficient, and it might well serve as a model to other text-books which deal with corresponding branches of school hygiene. We would commend Mr. Browne's definition of "over-pressure" as a very happy one; it is "a failure to reach the potentiality of the bodily and mental strength of any given child"; and every school teacher would do well to keep before him the writer's statement that "the holidays may be needed for the teachers, they may be desirable for the maintenance of home life and family ties, but they should be entirely superfluous in the matter of health."

The long range of subject-matter comprised within the title, "School Hygiene," is also dealt with a little unevenly in Prof. Shaw's work. The book contains some excellent chapters, notably those dealing with school furniture, postures, physical exercises and handwriting; but those dealing with sites and foundations of schools and sanitary fitments are somewhat poor, and generally insufficient. The reader will be puzzled by the reference, in the chapter dealing with ventilation, to "the well-known device of placing a board between the sashes of the window," and the scientific reader will not approve of the statement that the soil of the site should be free from organic matter. The book, however, is one which contains a great deal of valuable and well-expressed material, and it should be read by all those whose duty it is to be conversant with the subject of school hygiene. It is well printed, excellently illustrated, and contains a good bibliographical appendix.

OUR BOOK SHELF.

Illustrations of the Botany of Captain Cook's Voyage Round the World in H.M.S. "Endeavour" in 1768–1771. By the Right Hon. Sir Joseph Banks and Dr. Daniel Solander, with Determinations by James Britten, F.L.S., Senior Assistant, Department of Botany, British Museum. Part II.: Australian Plants. (London: Printed by order of the Trustees of the British Museum, 1901.)

THE first part of this work was noticed in NATURE, lxii. p. 547, October 1900, to which we may refer for explanations of its scope and character, as well as for some criticisms of the nomenclature and other points. The present part consists of plates 101 to 243, with descriptive letterpress, and illustrates the natural orders Myrtaceæ to Labiatæ, arranged after Bentham and Hooker's "Genera Plantarum." When complete, this work will be a great help to the botanists of East Australia, as it will comprise a considerable selection of the plants of the coast region from Cape Howe to Cape York. Almost all the natural orders are represented, though somewhat unequally. Thirteen genera of Myrtaceæ are figured, for example, and they include eight which are characteristically Australian. Nine species of the delicate and elegant genus *Utricularia* are also among those represented. In the way of names, such familiar genera as *Barringtonia*, *Careya*, *Sesuvium*, *Spermacoce*, *Olearia*, *Wahlenbergia*, *Trichodesma*, *Clerodendron* and *Plectranthus* are superseded by the obscure and usually less euphonious appellations of *Huttum*, *Cumbia*, *Halimum*, *Tardavel*, *Shawia*, *Cervicina*, *Borraginoides*, *Siphonanthus* and *Germanea*, respectively, on the ground of priority, often for a single species. Fortunately for the ordinary botanist and gardener, these and numerous other changes are not binding, and most of them are not recognised by Kew, Berlin and other botanical establishments which greatly influence the horticultural world. But the saviours of the familiar names are the nurserymen, who are careful not to mislead and mystify their customers by using fresh names for old plants.

W. BOTTING HEMSLEY.

Essays on the Theory of Numbers. I. Continuity and Irrational Numbers. II. The Nature and Meaning of Numbers. By Richard Dedekind. Authorised translation by W. W. Beman. Pp. 116. (Chicago: The Open Court Publishing Co.; London: Kegan Paul and Co., Ltd., 1901).

IN the first of these tracts Prof. Dedekind gives a theory of irrational numbers and of the arithmetical *continuum* which is logically perfect, and in form, perhaps, more simple and direct than any other which has been or could be suggested; in the second he proceeds, by a marvellous chain of subtle inferences, from the idea of a *manifold* (or system of distinguishable objects in the widest sense) to the series of natural numbers and the elementary operations of arithmetic. It is to be hoped that the translation will make the essays better known to English mathematicians; they are of the very first importance, and rank with the work of Weierstrass, Kronecker and Cantor in the same field. The translation is rather painfully literal, and does not convey much idea of the graceful style of the original; but it is, on the whole, correct. On p. 46, l. 15, "hereafter" is a wrong rendering of *hierauf*; on p. 52, l. 18, $\psi(s')$ and s should be $\psi(S')$ and S; p. 61, last line but one, "such" is superfluous. On p. 34 there is an amusing complication of errors. What the author means is, "In this sense" (or "in the light of this fact"), "which I wish to express by the words ἀεὶ ὁ ἄνθρωπος ἀριθμητίζει, formed after a well-known saying, I hope," &c. The reference is to the motto on the title-page of the German edition, which was coined by the author in imitation of the Platonic dictum, ἀεὶ ὁ θεὸς γεωμετρίζει.

M.

Familiar Butterflies and Moths. By W. F. Kirby, F.L.S., F.E.S. Pp. 114; with 18 plates containing 216 illustrations in colour. (London, &c.: Cassell and Co., Ltd.) Price 6*s.*

THE interest of this book centres in the coloured plates, which for the most part are excellent, and, so far as they go, will enable any one to name his insects supposing them to be among the number figured, for it must be remembered these are only a "selection." Probably the only really bad figure is Fig. 11 on Plate x. Nearly one-fourth of the number are butterflies, and nothing is figured beyond the Geometridæ. A not inconsiderable number of the species noticed do not occur in Britain, but this should be no drawback, because so many of our amateur entomologists travel abroad nowadays and form collections on their tours. The text is written to the figures and is sound, and the whole book is remarkably well got up. It does not pretend to be of the strictly scientific class, but we can commend it to the notice of those desirous of making a cheap, handsome and useful present.

Lehrbuch der mathematischen Chemie. Von J. J. van Laar. Pp. xiii + 224. (Leipzig: Johann Ambrosius Barth, 1901.)

THIS book does not cover the whole ground of mathematical chemistry, but is concerned solely with equilibrium. The treatment is thermodynamical throughout, Planck's potential function being taken as mathematical basis.

The first section of the book gives the general thermodynamical theory; the second section, which has eight times the bulk of the first, applies the theory to concrete cases, examples being given of all ordinary equilibria in gaseous, dissolved and condensed systems.

To those who desire a formal mathematical treatment of this important branch of chemical theory the book may be heartily commended, more especially as due attention is paid to experimental work where possible, so that comparison between theory and experiment is made easy.

Philip's Educational Terrestrial Globe. Diameter 9 inches. (London: George Philip and Son, 1901.) Price 15*s.*

IT is unnecessary here to urge that familiarity with the features of a good terrestrial globe is an excellent faculty for the student of geography to possess. Good globes of a serviceable size should be regarded as essential to the satisfactory teaching of the subject. Messrs. Philip's new globe shows commercial routes, ocean currents and the new political boundaries; and it is a very clearly-printed representation of the world. The distances in nautical miles are shown upon the principal steamship routes. Of course it is impossible to represent details upon a globe nine inches in diameter, as the scale is so small that the British Isles can be covered with a threepenny piece. But the correct general view obtained by the inspection of even a small globe has many advantages in the early stages of geographical instruction. For real work, however, it is essential that a complete meridian divided into degrees, and a wooden horizon, be provided. The importance of this is apparently not sufficiently appreciated by globe makers, for all the comparatively cheap globes, such as that under notice, are mounted with a semi-meridian of brass, which is sometimes not even divided into degrees, and they have no horizon. It ought not to be difficult to devise a light and inexpensive globe having both meridian and horizon, and doubtless such a globe could be produced if geographical publishers cared to give attention to it. The great value of a globe of this kind in connection with problems of geodesy, navigation and physical geography can only be appreciated by those who have learnt or taught the use of the globes.

Die Krystallisation von Eiweissstoffen und ihre Bedeutung für die Eiweisschemie. By Dr. Fr. N. Schulz. Pp. 43. (Jena: Gustav Fischer, 1901.) Price M. 1.20.

THE investigation of the chemical and physical nature of albumins[1] has always been hampered by the absence of criteria for the determination of the purity of the specific preparation. In chemical research we possess in crystallisation our most valuable method for purifying a substance, but the application of this method to albumins presents a complex problem.

For albumin crystals—crystalloids as they are termed—possess remarkable properties which distinguish them from other crystals: when treated with various reagents they absorb liquid and swell up; they do not separate from pure solvents, but the crystallisation is effected by salting out, or by the addition of mineral acids; as soon as the crystallisation is started, the separation is spontaneous and independent of the concentration, rendering it impossible to grow large crystals.

In other respects, however, these crystalloids resemble true crystals, in so far as they belong to well-defined systems, possess similar optical properties, and their inclination towards crystallisation depends on their state of purity.

Dr. Schulz in this pamphlet gives a complete account of all albumins which occur or have been obtained artificially crystalline, and of the methods used to obtain the latter results, and indicates that in many cases the elementary analyses of crystalline albumins, by different experimenters, show a welcome agreement.

Though Dr. Schulz in no wise dogmatises on the two theories of the crystallisation of albumin, he inclines to the view put forward by Hofmeister, who considers the phenomenon simply a case of gradual purification, in preference to Gabriel's assumption of the depolymerisation of the molecules of amorphous albumin.

The object of the author, we think, is in the first place to demonstrate the comparative uselessness of scientific research on substances of the purity of which we have no guarantee; he does not believe the amorphous character of certain albumins to be an inherent property, but attributes it to our ignorance of experimental conditions, intensified by the sensibility and labile nature of the albumin molecule. We can warmly recommend Dr. Schulz's pamphlet to the physiological chemist.

W. T. L.

Flowers and Ferns in their Haunts. By M. O. Wright. Pp. xix + 358. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1901.) Price 10*s.* 6*d* net.

THE authoress, in the "invitation" which prefaces this book, asks her readers to "spare an idle hour to look with the eye of the mind and the camera at a few of the flowers and ferns in their haunts." From this it will be evident that the work is not in any sense a scientific one and must not be criticised as if it were. It is a pleasantly written account of the more familiar flowering plants and ferns met with in a district in North America as they present themselves in the landscape. It is very fully illustrated with plates and drawings, the former being reproduced from photographs, the latter based on them. The plates, which represent the plants as they grow, are very good. The book will interest those who are familiar with the plants of which it treats, while others who know the wild plants of England will obtain from it a general idea of the common wild flowers of another country. A useful feature is a list of the scientific names of plants, which are mentioned in the text by their local popular names.

W. H. L.

[1] English current literature writes album*e*n and album*i*n indifferently—in America the term "egg-white" is frequently used, but rarely album*e*n.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Pearl and Pearl-shell Fisheries.

IN connection with Sir West Ridgeway's anxiety, as Governor of Ceylon, to revive the pearl fishery off the north-west coast of the island, and the appointment by the Secretary of State for the Colonies of so able a zoologist as Prof. Herdman to report on the subject—so classic to zoologists since Dr. Kelaart's paper and the display of fine examples of the pearl shells by the Indian Government in the London Fisheries' Exhibition of 1883—it may be interesting to mention the activity of the Queensland Government in this and allied subjects. Besides the work of Mr. Saville Kent and the recent (private) investigations of Mr. Lyster Jameson, the Queensland Government early last year appointed an able young zoologist, Mr. James R. Tosh, to make investigations on the life-history of the species which produces the pearl-shells of commerce, the formation and growth of pearls, and other questions bearing on the pearl fishery. He is now busy on Thursday Island. Moreover, Mr. Tosh informs me that the Queensland Government has just sanctioned a grant of 1500*l*. for the erection of a marine laboratory on a small island about two miles distant (from Thursday Island), and in the centre of the pearl-fishing grounds, though at some distance from the coral area. This laboratory will have, besides the work-room and quarters for Mr. Tosh and his staff, three concrete tanks for experimental work. W. C. McINTOSH.

Barham, Springfield, Fife.

A Possible Method of Attaining the Absolute Zero of Temperature.

IN your issue of July 25 there appeared an interesting article on the liquefaction of gases. It was shown that by rapidly evaporating hydrogen, Prof. Dewar obtained a temperature of 13–15° C. (absolute). By a similar use of the more volatile helium, probably an even lower temperature could be obtained.

But, as the author pointed out, such methods will not enable us to reach the absolute zero itself.

May I be allowed to suggest that thermoelectric phenomena will be of some use in attaining the desired result?

Peltier showed that if a current be passed across an antimony-bismuth junction, in one direction heat is developed and in the reverse heat is absorbed and an appreciable cooling effect obtained.

Similarly, in the case of any two other metals, heat is generated if the current traverses the surface of contact in one direction and is consumed if it passes in the opposite direction—the quantity of reversible heat being in each case proportional to the strength of the current and to a coefficient π, depending on the nature of the metals and their temperature.

So that, in general, if r is the resistance of the part of the circuit containing the junction, the energy converted into frictional heat is C^2rt and the energy converted into reversible heat is $C\pi$.

Hence, if H be the quantity of heat produced in t seconds we have:—

$$J.H = C\pi t + C^2rt.$$

By making a small hole at the junction of a bismuth and antimony bar, in which was placed a drop of water and a small thermometer, the whole being cooled to zero, Lenz found that when a current was passed from bismuth to antimony the water was frozen and the thermometer sank to −3·5° C.

Opposing this fall in the junction's temperature there are, in general, two influences. Firstly, when a current is passed through a conductor a frictional generation of heat occurs, which tends to mask the cooling effect. Secondly, when one part of a circuit is at a much lower temperature than the other parts, heat will flow by conduction from the hotter to the colder parts and thus again oppose further cooling.

When a stationary low temperature has been reached by the junction, we must suppose that as much heat is absorbed by the current in unit time as is imparted to the junction by means of both of those influences I have mentioned working together.

If, therefore, we could diminish or do away with these, a very great cooling effect could be obtained.

The frictional heating effect could be eliminated to a great extent by cooling the whole to the lowest temperature attainable by the use of liquid hydrogen. Recent experiments by Profs. Fleming and Dewar show that an astonishing fall in the specific resistance of most metals takes place at very low temperatures. Thus the specific resistances of copper and iron fall from 1564 and 9115 respectively at 0° C. to 289 and 1220 at −200° C., while at a temperature only 20° C. lower, these numbers become 144 and 660—*i.e.* the specific resistance at −220° C. is actually half that at −200° C. (*vide* Foster and Atkinson's "Electricity and Magnetism," p. 162, 1896 ed.) Such an enormous diminution in the specific resistance leads one to expect that at only 13–14° C. from the absolute zero—the lowest temperature yet attained by Dewar—the resistance would be practically negligeable, so that the term C^2rt in the above expression would become extremely small even when currents are employed considerably more powerful than those which can be used at ordinary temperatures for producing the Peltier effect.

If, then, π remained appreciably large, it is quite possible that matter could by such means be chilled almost to the absolute zero without the masking effect of frictional heat becoming sensible.

The second influence, namely, the flow of heat by conduction from the hotter parts of the bar to the cold junction, could be eliminated by avoiding a sensible temperature difference between the chilled junction and the rest of the circuit. For instance, each small section of the main circuit could be cooled simultaneously with the junction by means of a number of other chilled thermoelectric junctions. By the use of some such contrivance, the temperature of the junction need never become very much lower than that of the rest of the circuit.

The coefficient π would certainly alter with the temperature; unless it completely vanishes for all bodies at very low temperatures, such an effect could be corrected by suitably choosing the metals forming the junctions. GEOFFREY MARTIN.

Bristol, July 26.

Food of the Senegal Galago.

THE following facts may interest some of your readers as pointing out the possibility of a rare tropical animal being able to maintain itself unaided for some weeks in an English country town.

On the evening of June 20 an African galago (*G. senegalensis*) escaped from my laboratory in Eton. For some little time it was not seen or heard, but after that it constantly made its appearance in gardens, on house roofs, &c., until, on the night of July 28, it was caught while rifling a cupboard. Previous to this date it had never been seen inside a house, so that how it managed to obtain food is somewhat of a mystery. Probably it lived on fledglings which it took out of the nest, and later on the decrease in their numbers forced it to forage for less tempting prey. Its strictly nocturnal habits and great agility no doubt preserved it from being destroyed by dogs. M. O. HILL.

Pseudoscopic Vision without a Pseudoscope.

THE curious optical illusion which has been noticed by Prof. R. W. Wood and described by him in NATURE for August 8 under the heading of "A New Optical Illusion" has been known for many years.

It is mentioned in Helmholtz's great work on physiological optics in the chapter on the stereoscope and pseudoscope. It appears to have been first described by Prof. Joseph Le Conte in 1869 (see Silliman's *American Journal of Science* for January 1869 and *Phil. Mag.* February 1869).

Both these authorities mention a further similar illusion not described by Prof. Wood, which I think is a more striking illusion. If one looks at a pattern of which the distance between the centres of contiguous figures is somewhat less than the distance between the two eyes, and if we gaze at it in such a manner as if we were looking at a distant object beyond it, we then get the illusion of a much increased pattern at a considerably greater distance from the eye. A. S. DAVIS.

Roundhay, Leeds, August 9.

PHOTOGRAPHIC ANALYSIS OF THE MOVEMENTS OF ATHLETES.[1]

M. MAREY has again applied his chronophotographic methods in making an analysis of the movements of athletes while exercising their strength in different ways. His delightful experiments, which have been but little repeated by others, are described in detail in "Le Mouvement" (par E. Marey. Paris: 1894. Translated into English by E. Pritchard. London: Heinemann,

FIG. 1.—Composite picture of putting the weight by Sheldon.

1895). The methods are, for the most part, so simple, and the results so valuable, that they should prove themselves attractive to the student of those subjects in which movement of any kind is to be measured. In 1900, during the exhibition in Paris, there was a large gymnastic meeting and athletic sports. The administration of the exhibition nominated a commission of physiology and hygiene, for the purpose of following the meetings and gathering from that unique assembly of the best athletes in the world the information which it afforded. Its object was to determine, from a physiological point of view, the action of the various forms of exertion on the organic functions, viz. the respiration, the circulation of the blood, the digestion and, finally, the general health. The commission also studied different kinds of sports with a view to understand their mechanical details and discover the secret of the superiority of certain athletes.

The chronophotographic method gives a series of instantaneous photographs, on a long ribbon which is unwound; the number of pictures varies from fifteen to twenty or more per second. By this means the phases of a movement are perfectly represented. Figures so produced on a band being somewhat difficult to compare with one another, it was found to be more convenient to arrange them, as in Fig. 3, in three columns, the succession of pictures in each column reading from top to bottom, commencing on the left. The subject is that of "putting the weight" by the American athlete, Sheldon. The weight used by all competitors was 7·25 kilogrammes, = 15·95 lb., or the 16 lb. shot used in English athletic sports, and the distance covered was 14·02m. = 45·98 feet. Fig. 3 shows the athlete at the moment of his take-off from the right leg. At the end of his jump, and at the moment when the left foot touches the ground, he brings his right arm into action, which moves the shot upwards and forwards, giving it the greatest velocity possible.

The competitor is allowed a run of 2m., and he stands in a square traced on the ground, the boundary of which he must not pass. In order that the velocity of the different movements of the athlete may be estimated, it is necessary to introduce into the pictures the representation of both time and space. The time is measured by means of a chronograph (visible only in the five last pictures); it consists of a black dial furnished with divisions, over which a white pointer moves; the pointer makes one revolution in one second. The angular space swept out by the needle between two successive pictures indicates the time which has elapsed. An easy way of measuring these intervals is to determine the number of images contained in one, a half or quarter revolution of the needle. In Fig. 3, the last five pictures were made in one quarter of a revolution of the pointer, or at the rate of twenty pictures per second, so that between two successive images the displacement (which is estimated for any point on the body) is made in 1/20th second, and it is the same for the displacement of the weight. The true extent of displacement is finally determined by placing a divided metric scale on the ground; this rule is photographed at the same instant as each new position of the athlete, and it serves as a scale whereby the path traced out by each point under consideration may be computed—M. Marey gives the following *method of comparing images by superposition.*

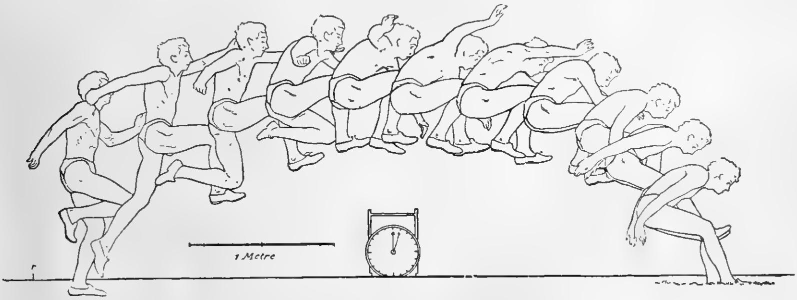


FIG. 2.—Composite picture of long jump by Sweeney.

[1] The accompanying illustrations are from *La Nature.*

Project the first image of a series (Fig. 1) on to a piece of paper, mark the ground line and a fixed point on it, r—a small stick planted in the ground—then trace with care the contour of the body and limbs of the gymnast. This done, project the second figure of the series. In order to bring this image into its correct position, relative to the first, shift the paper until the ground line and the point of reference correspond with those points already marked on the paper. We shall see that the second image does not coincide with the first; since each part of the body has moved, trace the outline of the second image and repeat the operation for each image in the series. The result is a composite diagram, and by reference to the original pictures it is easily interpreted. In the composite diagram only every third image in the original has been used, otherwise the result would have been confusing. In Figs. 1 and 3 the movements of the athlete are put before us in series. He begins with a jump, which imparts a certain acceleration to the shot; during this period the arm is inactive, since the shot rests on the shoulder. Next is added a new acceleration, due to the arm. In order to discover, for example, the force acting on the shot at any instant, all the images of the shot must be represented (the figure of the man being left out, as it would complicate the diagram). After the successive positions of the shot have been traced on the paper, the accelerations can be determined and their curve traced; by means of this the work done by the

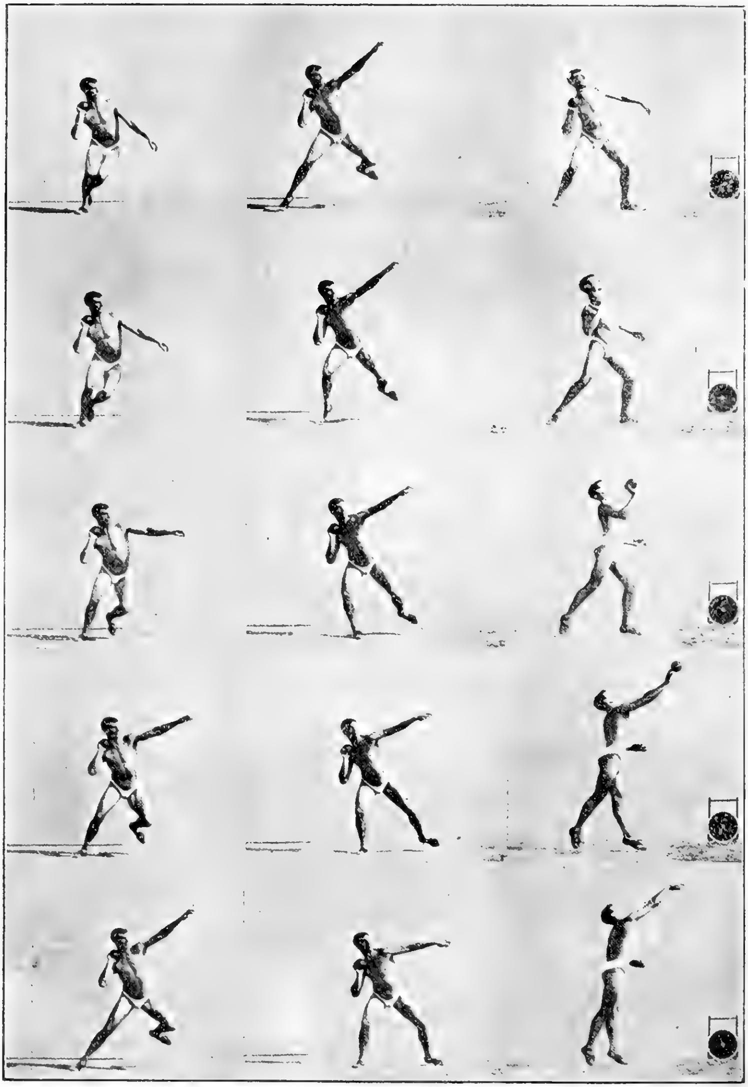


FIG. 3.—Putting the weight by Sheldon.

athlete at any instant may be found. M. Marey's excellent work in chronophotography is again illustrated by the analysis of the long jump (Fig. 4). The columns are to be read from right to left and from top to bottom. As in the former diagram, a composite picture has been made from several consecutive images. In this instance, owing to the rapid movements of the jumper, the figures have less tendency to be confused by superimposition. By eliminating every other image, a clear and comprehensive representation of all the actions has been obtained — actions which no language could describe with sufficient accuracy. The means of determining the extent and the duration of these movements is as perfect as possible. The chronograph shows that the interval between the images is 1/14th second, whilst the metric scale gives the length of the jump as 4·69 m. The same method of measurement shows that the space traversed by the jumper in 1/14th second was 52 cm., giving him a velocity of 7·28 m. per second. If the detail of Fig. 2 is closely studied, it will be seen that different points of the jumper's body do not cover the same space in the same time. For example, the head is displaced with unequal velocities, because the arms and legs are at each successive moment in different positions. Several other analyses of the movements of celebrated athletes, French and American, were obtained, and in all cases much light has been thrown on the rapid movements of the limbs in the case of clearing hurdles in a race.

The evidence collected in each section of the inquiry instituted by the commission of physiology and hygiene should prove itself to be most interesting and valuable matter, since it should lead to a complete modification of the system of athletic training and establish it on the study of nature itself, instead of on theories devoid of experimental foundation and often contradictory. M. Marey's methods of time measurement are very excellent, simple and effective, and a study of his work, "Le Mouvement," ought to stimulate English experimentalists to work in the same direction, which should prove itself to be a fruitful field for research in a country in which athletic exercises of every kind are so vigorously practised by all classes.

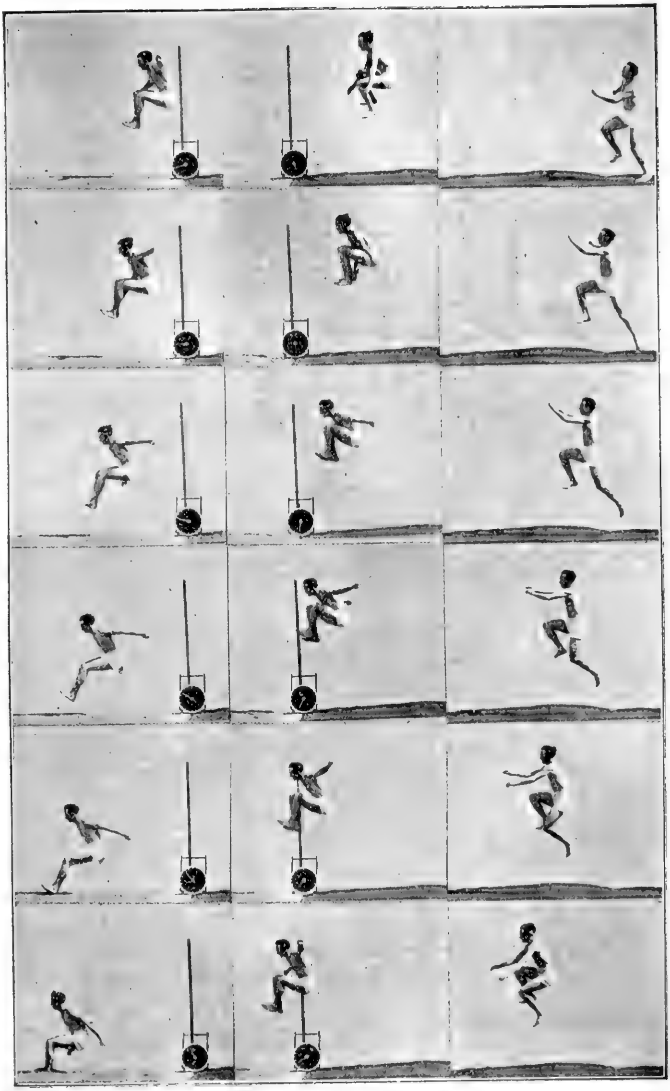


FIG. 4.—Long jump by Sweeney.

PROFESSOR WILHELM SCHUR.[1]

IT was with great regret that we had to announce last week the death of Prof. Wilhelm Schur, of Göttingen, a loss which deprives, not only astronomy of one of its most ardent and enthusiastic workers, but many of us of a kind and devoted friend. The loss will be felt personally by a great number of Britishers and Americans who have studied at the Göttingen University and who met Schur, not only in the lecture theatre and observatory, but at his private home.

Schur was born on April 15, 1846, and first took a great interest in astronomy at the Altona Observatory, where the director of the Observatory, Prof. A. C. Petersen, was one of his near relations. His first studies were commenced at Kiel in 1863, and three years later he migrated to Göttingen, where he graduated, his thesis being a computation of the orbit of the double star 70 *p* Ophiuchi after the new formula of Klinkerfues. Schur always took a great interest in after years in this double star, as is shown by later publications. Leaving the University, he made a tour for further study, working at Berlin under Auwers at the new reduction of Bradley's observations, and under Foerster at the Observatory. While at Berlin he was made assistant at the Geodetic Institute, and remained there until he was called (in 1873) by Winnicke to Strassburg. After spending some time there, he was made observer, and worked, as he had always done, with untiring zeal and energy. He was chosen to form part of the transit of Venus expedition in 1874, which set out for the Auckland Islands under the direction of Seeliger.

It was in connection with this work that Schur became so intimately familiar with the working and details of the heliometer, and since then he proved himself to be one of the greatest authorities, if not the greatest, upon this important instrument. Schur, however, was not content to restrict his energies to this instrument alone, but developed a many-sided interest for all the instruments at the observatory. Thus, to take two instances, he made a series of important lunar observations with the transit instrument of Cauchoix, and numerous observations of variable stars, and completed a minute investigation on the optical properties of different varieties of glass, before the construction of the large refractor.

In 1886 Schur was called to Göttingen to fill the chair of practical astronomy, which had become vacant owing to the death of Klinkerfues. The first few years spent there were devoted to the rebuilding of the observatory, the arrangement of the library, and the laborious computations and publication of Klinkerfues' observations. The observatory became the possessor of a fine new large Repsold heliometer, so that Schur was able to return again to his favourite instrument. In his hands and with his energy a great amount of useful work was accomplished, and he investigated more especially in the greatest detail the constants and many peculiar sources of error of the instrument.

Perhaps the most important of these researches was contained in the very complete work on the stars in the cluster of Præsepe, in which he brought together in a masterly way everything that is necessary for the reduction of heliometer observations. His most recent great work, and one which he laid before astronomers at the Heidelberg conference, was that relating to the triangulation of the star clusters h and χ Persei.

Up to the last, Schur sustained his interest in collecting and working up old observations, and in the past few years, under his guidance, Dr. Stichtenoth made a new reduction of Olbers' observations of comets, which appeared in 1898 as an appendix to Schilling's "Leben Olbers." More recently Schur was busy with collecting material of astronomical work done by astronomers in the province of Hanover, and the results of this study are already completed, but not yet published.

Although Schur was not among the favoured few to whose name some epoch-making discovery could be attached, yet his observations and reductions will endure as examples of exact and careful work and will prove both valuable and useful in future investigations.

WILLIAM J. S. LOCKYER.

[1] For most of the details in this notice I am indebted to a notice in the *Astronomische Nachrichten* (No. 3731).—W. J. S. L.

BARON DE LACAZE-DUTHIERS.

THE death of Prof. de Lacaze-Duthiers on July 21, in his eighty-first year, deprives the world of science of a renowned and energetic naturalist whose active life was devoted to the advancement of scientific knowledge and interests.

From an obituary notice in *La Nature* we learn that Henri de Lacaze-Duthiers was born at Montpezat (Lot-et-Garonne) on May 15, 1821. He began the study of medicine at Paris, but soon devoted himself to zoology, and in 1854 was appointed professor of zoology in the University of Lille. At his request he was afterwards entrusted by the Government with the task of studying the nature of corals on the Mediterranean coasts. He spent several months along the Algerian coast, and then returned to Paris with an abundance of material. His great work, the "Monographie du Corail," was the result of this expedition, and its publication inaugurated a new stage of appointments in his career. He was appointed maître de conférences at the Normal School in 1864, and in the following year became professor of zoology at the Paris Museum of Natural History. Three years later Lacaze-Duthiers passed from the Natural History Museum to the Sorbonne, where he accepted the chair of zoology, and finally, in 1871, he was elected a member of the Paris Academy of Sciences, and later became president of the Academy.

Among Lacaze-Duthiers' published volumes may be mentioned his "Histoire naturelle du corail," "Histoire de l'organisation et du développement des mœurs du Dentale" and "Le Monde de la mer et ses laboratoires." In 1873 he founded the *Archives de la zoologie expérimentale*, and he was the author of numerous papers and memoirs which have contributed to the development of zoology. The two Government stations of marine biology, established by the exertions of Lacaze-Duthiers, are memorials of his influence upon zoological science. The first was founded at Roscoff, in one of the most attractive and favourable collecting regions in Brittany, and has continued to grow in importance for more than a quarter of a century. As this station, however, could be serviceable during summer only, it gave rise to a smaller dependency of the Sorbonne in the southernmost part of France, on the Mediterranean, at Banyuls-sur-mer, which has the additional advantage of a Mediterranean fauna.

Many British and American students have been welcomed to these institutions and have enjoyed the advantages they afford. Describing the Roscoff laboratory several years ago, Mr. Bashford Dean said: "The stranger who writes to Prof. de Lacaze-Duthiers is accorded a work place which entitles him gratuitously to every privilege of the laboratory—his microscope, his reagents, even his lodging-room should a place be vacant. It seems, in fact, to be a point of pride with Prof. Lacaze-Duthiers that the stranger shall be welcomed to Roscoff and, upon entering the laboratory for the first time, feel as much at home as if he had been there a week." This liberal spirit was a characteristic of Lacaze-Duthiers; he was always ready to facilitate the study of nature by any means within his power, and right up to the time of his death he occupied himself with investigations of scientific problems. As a tribute of admiration for the good and useful work done by him in zoology, his pupils presented him with a magnificent engraved portrait of himself in 1887; and at a dinner given in his honour by the Scientia Club in 1890, M. Charles Richet, who presided, referred to him as "the conqueror of the sea and apostle of zoology." His pupils and colleagues were, in fact, deeply sensible of his great services to science, and lost no opportunity of expressing their esteem.

Lacaze-Duthiers worked in his laboratory at Banyuls up to a few days of his death, and almost up to his last hour his faculties were engaged in the extension of scientific knowledge. He was the animating spirit of French zoology and the mentor of many living naturalists. He devoted his life and his means to science, and worked for her interests without regard for fatigue or considerations of age. In announcing his death to the Paris Academy of Sciences, which adjourned the meeting of July 22 to show regard for him, M. Fouqué, the president, remarked:—"Son esprit était ouvert à toutes les nouveautés scientifiques, sa parole claire et facile, son enseignement plein d'entrain. Il aimait la discussion et savait en faire jaillir la lumière. Il laisse parmi nous le souvenir d'un Confrère érudit et laborieux, doué d'une prodigieuse activité, habile à résoudre les problèmes compliqués que soulève l'organisation du règne animal."

Not only France, but the whole scientific world is poorer by the death of so great a naturalist.

NOTES.

WE regret to see the announcement that Prof. Baron von Nordenskjöld, the renowned Arctic explorer, died at Stockholm on August 12.

ACCORDING to the Copenhagen correspondent of the *Temps*, the two Nobel scientific prizes of 200,000f. have been awarded to Prof. Finsen, of Copenhagen, for his treatment of lupus by light, and the Russian physiologist, M. Pawloff, for his works on nutrition.

THE Fifth International Congress of Zoology was opened at Berlin on Monday in the buildings of the Reichstag, the interior of which has been arranged for the convenience of the members of the congress. In the absence of the Crown Prince, who is the patron of the congress, the foreign delegates were welcomed by Prof. Moebius, the president, who moved that the assembly should send a telegram expressing profound sympathy and regret to the Emperor of Germany. This proposal was seconded by Prof. E. Perrier, of Paris, and was unanimously adopted. A telegram expressing thanks for the sympathy was received from the Emperor on Tuesday. Other speakers at the opening meeting were the Chief Burgomaster of Berlin, Herr Kirchner, and the Rector of Berlin University, Prof. Harnack. The meetings will be held throughout this week, and the congress will be concluded on Sunday with a visit to the biological station on Heligoland.

THE annual awards of prizes by the Reale Accademia dei Lincei, of Rome, are as follows:—The Royal prize for chemistry has been adjudged to the late Prof. Amerigo Andreocci for his researches on heterocyclic compounds and on the santonine group, and other papers. The Royal prize for philosophy and moral science has been adjudged to the late Prof. Carlo Giussani. In political science and jurisprudence no award has been made, and the same is true of the Santoro prize relating to agricultural zoology. The two prizes instituted by the Minister of Public Instruction in favour of teachers in secondary schools for work in natural science have been divided, awards being given to Profs. Liberto Fantappiè (Viterbo), Antonio Neviani (Rome), De Toni (Venice), and Giacomo Trabucco (Florence). Two "Ministerial" prizes of a similar character for philosophical and social sciences are awarded to Profs. Luigi Einaudi (Turin) and Aurelio Covotti (Palermo). At the special meeting of the Accademia at which these awards were made, an obituary discourse on the late Prof. Angelo Messedaglia was given by Signor Luigi Luzzatti, and an address was read by Signor Gerolamo Boccardo on science and social progress. A list of Prof. Messedaglia's writings is appended to the former discourse in the *Rendiconti delle Sedute solenni* containing the report of the meeting.

THE twelfth annual general meeting of the Institution of Mining Engineers will be held at Glasgow on September 3-6 under the presidency of Sir W. T. Lewis, Bart.

A REUTER telegram from Geneva states that a meeting of the International Association of Botanists was held in the University there on August 7. A number of foreign universities and societies, including the Universities of Oxford, Cambridge and Glasgow, and Trinity College, Dublin, were represented.

THE Paris correspondent of the *Chemist and Druggist* states that with a view to give an impetus to the study of applied chemistry in Paris, it has been decided to build additional laboratories at the Conservatoire des Arts et Métiers. The initial expense is estimated at 500,000f. (20,000*l.*), and the annual upkeep at something over 3000*l.* The laboratories will also be used for experiments in physics and mechanics.

THE *Times* records that the German South Polar expedition sailed from Kiel on Sunday by the steamer *Gauss.* Herr Rothe, Imperial Under-Secretary of State for the Interior, thanked the members of the expedition in the name of the Emperor and of Germany, and hoped that their labours would meet with complete success. Prof. von Drygalski, the leader of the expedition, replied on behalf of the expedition.

THE balloon in which M. Santos Dumont made his recent trial trips has met with an accident which has placed it beyond repair, so a new one is being constructed and will be ready by September 1. The new balloon will have nearly the same volume as the one that came to grief on August 8—34 metres in length and 6 metres in diameter in the centre—but, instead of being cylindrical, it will be ellipsoidal in shape, and the *ballonet*, instead of being at one end, will be placed in the middle.

THE wireless telegraph station established on the Nantucket lightship by the *New York Herald* enables passengers by incoming vessels equipped with the Marconi instruments to enter into communication with the American Continent and through it with the whole world from fourteen to sixteen hours earlier than is the case at present. The installation of the station is rapidly approaching completion. The *Lucania,* which sailed from Liverpool on Saturday last, will be the first Transatlantic liner to greet the New World with a wireless message sent from a ship at sea.

THE *Pioneer Mail* of Allahabad states that as a consequence of the continued fall in prices, the area under indigo in the North-West Provinces of India is rapidly falling. In 1900 there was a slight and temporary recovery, but during the present year there has again been a very marked decline. According to the preliminary statement received from the village accountants, the total area sown with indigo up to the middle of April this year amounts to 119,313 acres, as compared with 188,645 acres returned last year; while that reported to be irrigated from canals up to the end of May last is 78,894 acres, against 162,298 acres returned last year. The decrease in the former area amounts to about 37 per cent., in the latter to 50 per cent.

THE Society of German Engineers has decided to prepare and publish the trilingual technical dictionary proposed a year ago, and circulars inviting cooperation have been sent to technical societies and engineers likely to assist the project with suggestions and lists of words. Dr. Hubert Jansen has been appointed editor of this "Technolexicon," and an editorial office has been established at Berlin (N. W. 7), 49, Dorotheenstrasse. The dictionary will appear in three volumes, namely: vol. 1, German-English-French; vol. 2, English-German-French; and vol. 3, French-German-English. To make the work as complete as possible, it is hoped that many collaborators will collect technical words and expressions and send to the editor those which do not occur in an ordinary dictionary. A note-book for setting down such uncommon words and expressions which crop up in connection with engineering work will be sent to persons who are willing to assist the project. These words are acceptable even if the equivalents in the two other languages are not known. The editor would also be glad to receive references to, or copies of, good special dictionaries, technological text-books, price-lists and catalogues referring to any branches of industry or handicraft. We suggest that the printed pocket-books used by electricians, engineers, surveyors, architects and others contain a large number of technical terms for which equivalents in French and German are difficult to find. It is not clear from the prospectus whether the dictionary will include technical terms used in physics and chemistry as well as those which belong to engineering. If not, it will sometimes be difficult to distinguish between scientific and engineering terms. For instance, electrochemistry is an industry, so its technical terms will be included in the dictionary; but it is also a science, and its scientific terms should also be included. If the scope of the dictionary is made sufficiently broad to cover physical as well as engineering science, the work should be of value to students of foreign scientific literature.

THE *Meteorologische Zeitschrift* for July contains a very interesting and comprehensive article by Prof. H. Ebert, of Munich, on the phenomena of atmospheric electricity, considered from the standpoint of the theory of ions, or carriers of positive and negative electricity, generated by the medium of radiation. The electrification of a gas has, especially since the discovery of the Röntgen rays, become a subject of fundamental importance, and has occupied the attention of several physicists, more particularly Messrs. Elster and Geitel, of Wolfenbüttel, and Mr. Wilson, of Cambridge, who have independently arrived at important and very similar results. They have also greatly improved the necessary apparatus and methods of measurement, by which means they have been able to show the connection between the electric conductibility of the air and artificially ionised gases. The following are some of the results deduced from the ionic theory. (1) The greater the solar radiation the less is the electric potential generally observed. (2) The ions generated at a great altitude are maintained for a certain time in the air and participate in its movements. (3) Dust, and especially aqueous vapour, obstruct the mobility of the ions, and therefore diminishes the conductibility of the air. (4) Negative ions move at greater speed than the positive. (5) The ions form condensation nuclei which, in the case of supersaturated damp air, are exhibited as fog or cloud; hence the negative ions are more suitable for forming nuclei than the positive. The subject of the condensation properties of ionised air has been carefully investigated by Mr. Wilson, and some of the results have been published in the *Philosophical Transactions* and other scientific papers.

MR. W. L. MOORE, chief of the U.S. Weather Bureau, has given an official opinion upon the value of cannonading as a means of preventing the fall of hail. The following extracts from the *Monthly Weather Review* show that he does not attach any importance to the Stiger method of bombardment, now so widely adopted in Italy, southern Austria and southern France:—"It consists essentially in sending vortex rings of smoke and air upward toward the clouds; but the most powerful Stiger cannon that have yet been employed do not send these rings higher than 1200 feet above the ground, and, therefore, utterly fail to reach the clouds. On this account the distinguished Austrian meteorologist, J. M. Pernter, has maintained that if there is any virtue whatever in the idea, the experimenters must use much more powerful apparatus. But there is no satisfactory evidence that the cannonading or the vortices had any influence whatever on the hail. Both theory and practice agree in this conclusion. Theoretically it was imagined by Mr. Stiger that hail is formed in quiet spots in the atmosphere where the atmospheric moisture could crystallise out in large crystals in a manner analogous to the formation of large crystals of salt in liquid solution. But this is a very foolish notion; there are no such quiet spots in the atmosphere, and hailstones are not crystals, but masses of ice, with only a feeble or partial crystalline structure. Even the perfect crystals of the snowflakes are formed in the midst of rapidly-moving air, so that the whole theoretical basis for hailstorm cannonading falls to the ground. . . . After examining all that has been published during the past two years, my conviction is that we have here to do with a popular delusion as remarkable as is the belief in the effect of the moon on the weather. The uneducated peasantry of Europe seem to be looking for something miraculous. They would rather believe in cannonading as a means of protection and spend on it abundance of money, time and labour, than adopt the very simple expedient of mutual insurance against the losses that must inevitably occur."

NO. 169 of the *Bulletin* of the French Physical Society contains a brief note on some experiments by Mr. L. Benoist on the transparency of bodies for Röntgen rays. The method adopted consists in plotting curves in which abscissæ represent atomic weights and ordinates represent the corresponding transparencies. In this way it is possible to establish the existence of a functional relation between the atomic weight and the transparency, and, further, to discriminate between different kinds of rays which give different curves.

Bulletin No. 98 of the U.S. Department of Agriculture consists of reports by Drs. Atwater and Sherman and by Mr. R. C. Carpenter on food consumption and metabolism, and on the mechanical efficiency of bicyclists. The experiments were made during a six days' bicycle race, and consisted in analytical determinations of the heat equivalent of the food consumed on the one hand, and estimates of the work done as deduced from calculations of air resistance and wheel resistance on the other hand. The experiments show, among other results, the great amount of easily-digested food required by the competitors, the greatly increased metabolism of nitrogen, the large amount of work done per day by the athletes in this competition, which averaged in one case more than ten million foot-pounds, or more than five times the average daily work of a man as estimated by Dr. Thurston, and, lastly, the high efficiency of the human subject as a motor, for which the authors obtain estimates ranging as high as 45 and 60 per cent. In regard to the accuracy of the determinations, a good deal of uncertainty must exist as to the amount of energy derived from combustion of body tissue by the bicyclists, and also as to the actual resistance overcome, which latter could best be determined by dynamometer observations. The determinations of the efficiency of the human subject have an interesting bearing on the question as to whether organic life is subject to the second law of thermodynamics or Maxwell's "demons" actually exist in the animal kingdom. We should also like to see dietary studies taken in periods of exceptional brain activity, as, for example, on subjects sitting for a competitive examination.

AN interesting and useful pamphlet has recently been issued by Mr. A. Hilger, containing full description and details of manipulation of the Michelson Echelon Grating. Many of the principal Universities of Europe have been provided with this very powerful means of spectroscopic determination, and the experience gained has been sufficient to permit the designing of a standard type of instrument. In this the thickness of each plate is 10 mm., and the width of each step 1 mm. The progressive precision in the working of the plates has enabled Mr. Hilger to avoid the considerable loss of light which was caused, in the original instruments, by the plates not being mechanically clamped together. They are now held in position by a screwed frame, which can be so adjusted that no distortion is perceptible, while the increase in brilliancy of the spectra is very noticeable.

WIRELESS telegraphy is in use upon ships engaged in the naval manœuvres, and it enables a battleship to communicate with a cruiser fifty or sixty miles away with greater ease than the same ship could be communicated with at a distance of ten miles in clear weather a year or two ago. But the *Times* special correspondent with one of the fleets remarks that the method, although independent of the weather, is still subject to one very serious drawback. The communication is not, and cannot be, a private or exclusive one, except so far as the messages are transmitted in cipher. Even so, every ship within range which is fitted with the necessary apparatus can take in the message, and if an enemy's ship is within range she can, by setting her own apparatus at work, break up the message and render it unintelligible. It is perhaps more politic to take it in clandestinely and work out the cipher—a thing which it is seldom very difficult to do and never altogether impossible if sufficient cipher material be obtained and sufficient time be devoted to the task. The moral is to employ as difficult a cipher as possible and to change it as soon as there is any reason to suspect the enemy has discovered it. But, even so, wireless telegraphy as at present practised is full of limitations and pitfalls which only experience can eliminate. It will never be quite satisfactory for war purposes until the transmitting instrument can be so adjusted as to emit vibrations of different pitch at the will of the operator and the receiving instrument rendered sensitive only to vibrations of a given pitch at a given moment. In that case, every ship in a fleet could have its own pitch and be sensitive only to messages addressed to itself in that particular pitch, while, unless an enemy within range happened to be attuned to the same pitch at the moment—a very unlikely contingency if the pitch were changeable at will—he would be powerless to intercept the message.

THE electrolytic dissociation theory of Arrhenius is severely criticised by Prof. Kahlenberg in a paper in the *Bulletin* of the University of Wisconsin (No. 47, February 1901), in which a great deal of experimental evidence in contradiction to the theory is brought forward. Prof. Kahlenberg has measured the conductivity of a number of electrolytes at 0° and 95° and calculated the degree of dissociation from these measurements as well as from determinations of the lowering of the freezing point and rise of the boiling point. The two sets of results he has thus obtained are far from concordant, from which he concludes that the dissociation theory is incorrect and doomed to early extinction. This theory, even though it has not met with universal acceptance, is not, we think, to be so easily overthrown, especially until some more satisfactory and fruitful alternative hypothesis is put forward to take its place. It is interesting to note that another American professor, Prof. H. C. Jones, of the Johns Hopkins University, is now contributing a series of valuable "Chapters in Electrochemistry" to the *Electrical Review* of New York, in which the subject is treated entirely from the point of view of the ionic theory, of which Prof. Jones is a vigorous adherent.

THE *Times* correspondent at Simla states that since the Pasteur Institute at Kasauli was opened a year ago, 321 patients have been treated, including 96 from the British Army and 50 European civilians. Not a single failure has occurred among the Europeans, but two natives died. Both of the latter had been badly bitten and arrived too late to be saved. The complete success of the Institute, which is under the charge of Major Semple, of the Army Medical Service, means a great saving to the Government, as soldiers need no longer be sent to Paris for treatment. It is hoped that funds will be provided to make possible the preparation of anti-toxins for enteric, snakebite and tetanus.

IT is a matter for regret when familiar names like Octopus have to disappear from the effective list, yet, according to Mr. Hoyle (*Manchester Memoirs*, xlv. No. 9), this must be replaced by Polypus on the ground of priority. In the same communication, the question is raised whether the name Histiopsis is preoccupied by Histiops—a point on which experts differ. In No. 4 of the same serial, Mr. Hoyle gives an instance of the danger of making genera and species on imperfect specimens. Part of a cuttlefish taken from a sperm-whale's stomach was referred to a new genus on account of its being apparently covered with regularly arranged quadrangular scales. Specimens recently acquired suggest that the appearance in question was due to decomposition.

THE secretary of the British South Africa Company has sent us a copy of the "Reports on the Administration of Rhodesia, 1898-1900," issued by the Company. One section is devoted to "Notes on the Fauna and Flora of North-eastern Rhodesia," by Mr. C. P. Chesnaye. From this we learn that the prospect of the survival in considerable numbers of the larger mammals and reptiles in the district to the west of Loangwa and in the swamps of Bangweolo and Mweru is very hopeful. The elephant is still met with in large herds, owing to its living for the greater part of the year in almost inaccessible swamps. The formation of a game-reserve to the east of Lake Mweru will probably largely aid in the preservation of this and other species, as it is believed that the elephants now hunted by Swahili traders to the south of Tanganyika will gradually retire to the reserve. Rhinoceroses are still fairly numerous, while hippopotamuses abound. The rinderpest which swept over the country in 1893 decimated the buffalo, eland and lichi antelope, but the country is gradually recovering from the scourge, and most districts are now very rich in game of all kinds, especially roan antelope, eland, Lichtenstein's hartebeest, puku, lichi and zebra. A few of the beautiful sable antelope still survive in the Mweru district, and around the north end of the lake the swamp-loving sitatunga antelope is plentiful. The rare sassabi hartebeest is restricted to a small area west of Lake Bangweolo. The dreaded tsetse-fly is stated to be prevalent in the valley of the Loangwa from the Zambesi to the confines of the Nyasa plateau, as well as in one other district, but to be absent from the greater portion of the Bangweolo country. Whether the latter part of the statement is true requires confirmation, but most of the territory seems free from "fly."

WE have received from the New Mexico College of Agriculture *Bulletin* No. 37, containing "Notes on the Food of Birds," by Mr. T. D. A. Cockerell. This is chiefly of local interest.

IN the *Bollettino* of the Italian Geographical Society, Signor Cesare Cipolletti continues his papers on the Argentine Republic, dealing with the regions of the Rio Negro and the Rio Colorado. Appended to a note on the Italian sphere of influence in Africa is a map showing the boundaries of the colony of Eritrea, compiled from official sources.

A PAPER by Herr S. Puchleitner in the *Mittheilungen* of the Vienna Geographical Society, on the glacial period in the Southern Carpathians, gives an excellent summary of recent research in this region, and more especially of de Martonne's valuable work on cirques. Dr. Kurt Hassert publishes an account of his journey through Montenegro during the summer of 1900, in the same number.

Petermann's Mittheilungen contains an article on the magnetic work to be undertaken by the German South Polar Expedition, by Dr. Bidlingmaier, the meteorologist and magnetician of the expedition. It includes the official programme of observations on the term days, and of the international scheme of cooperation, whereby it is hoped to obtain synoptic charts showing the magnetic condition of the whole globe on these days. Dr. Hans Gazert, the doctor of the Expedition, also contributes a paper on the bacteriological problems to be investigated.

A NUMBER of the *Abhandlungen* of the Vienna Geographical Society, just issued, contains a paper on the contrasts in climate on the east and west coast regions of continents in extra-tropical latitudes, by Dr. Ludwig Coellen. The author arranges the results of observations, chiefly obtained from tables published by Buchan, Hann and Woeikof, in such a way as to clearly bring out the salient points of difference; but it may be doubted if the selection of individual stations on which his generalisations are based is always satisfactory. We note that the direct influence of ocean currents is properly relegated to a secondary place.

IN a former paper on barisâl guns, &c., in the province of Umbria (*Boll. Soc. Sismol. Ital.*, vol. iii. 1897, pp. 222–234), Dr. Cancani attributes these phenomena to endogenous causes. He continues the subject in the last number of the same journal (vol. vii. 1901, pp. 23–47), describing similar noises which have been observed in the districts round Isernia and Cosenza and in Umbria and Latium. In the latter case he argues that the sounds were neither of artificial nor of atmospheric origin; and, as slight tremors were noticed in some instances to accompany them, his views receive considerable support from the recent observations.

MEMOIRS and notes upon many aspects of polar exploration are included in the "Antarctic Manual" prepared for the use of the members of the British Antarctic expedition. Mr. George Murray, F.R.S., is the editor of the manual, and Sir Clements Markham, K.C.B., contributes a preface in which he surveys the contents, and remarks that the volume "is presented to the expedition by the president and council of the Royal Geographical Society," so that the Royal Society is not officially concerned with the work. Among the subjects of papers in the volume are:—ice nomenclature, astronomical data, tidal observations, pendulum observations, terrestrial magnetism, climate, wave observations, the aurora, atmospheric electricity, chemical and physical notes, geology, volcanoes and volcanic action, ice observations, the collection of rocks and minerals, zoology, botany, sledge-travelling, geography, and an Antarctic bibliography. The manual thus contains in a compact form practically all that is known about South Polar regions, and also records of experience in Arctic exploration.

THE additions to the Zoological Society's Gardens during the past week include a Crab-eating Raccoon (*Procyon cancrivorus*) from South America, presented by Mr. George Lancefield; a Wild Swine (*Sus scrofa*) from Persia, presented by Mr. B. T. Ffinch; a Cardinal Grosbeak (*Cardinalis virginianus*), two Bluebirds (*Sialia wilsoni*) from North America, presented by Colonel Ashburner; a Golden Eagle (*Aquila chrysaëtos*) from Scotland, presented by Mr. J. Monro Walker; two Stone Curlews (*Ædicnemus scolopax*), British, presented by Mr. A. E. Chaplin; an Orange-cheeked Waxbill (*Estrelda melpoda*) from West Africa, presented by Mr. W. S. Primley; a Kinkajou (*Cercoleptes caudivolvulus*) from South America, deposited; a Hoffmann's Sloth (*Cholopus hoffmanni*) from Panama, purchased.

OUR ASTRONOMICAL COLUMN.

ENCKE'S COMET.—A telegram sent out from Harvard College Observatory announces that the first observation of this periodic comet was made by Prof. Wilson at Northfield, on Monday evening, August 5.

The determination of position was as follows:—

$$\left.\begin{array}{l}\text{R.A.} = 6\text{h. } 2\text{m. } 2\cdot8\text{s.}\\ \text{Decl.} = +31^\circ\ 42'\ 30''\end{array}\right\}(1901).\quad \begin{array}{c}\text{August 5d. 9h. 25m. 3s.}\\ \text{G.M.T.}\end{array}$$

OBSERVATIONS OF MARS.—In the *Bulletin de la Soc. Astronomique de France* (1901, pp. 345–355), MM. Flammarion and Antoniadi give an account of their new observations of the planet Mars made at the Juvisy Observatory during the period 1900 October 23 and 1901 July 6. Two charts are given, one showing the northern hemisphere as a polar projection, the other giving the zone from $+80^\circ$ to -50° lat. on Mercator's projection.

Tables are given showing the varying dimensions of the North Polar snow-cap, which at the summer solstice had a diameter of about twenty degrees. The charts are described in detail, showing the differences from former observations. Attention is again drawn to the half-tone shading which apparently extends over the northern hemisphere from the pole to latitude 45°, limited towards the south by the region containing the canali.

At Juvisy, fifty canali have been seen, forty-six of which agree with the observations of Schiaparelli, and one from the list of Cerulli. Only three cases of gemination have been noticed, the most prominent being Cerberus and Casius, which were visible without difficulty. The Styx was also suspected of duplicity, but the components were not sharply separated.

VARIATIONS OF THE MAGNETIC NEEDLE.—M. Souleyre commences a discussion of the possible causes of the variations of the magnetic needle, and in his first article outlines the production of currents and other disturbances in the solar corona by the action of the planets, these reacting on the supposed electrical constitution of the corona and other solar surroundings. The extension of the theory to explain the periodicity of sunspots, terrestrial magnetic storms and auroræ is then presented, special attention being given to the effect of planetary disturbance (*Bull. Soc. Ast. de France*, 1901, pp. 362–370).

VARIATION OF EROS.—Supplementing his recent note, M. André furnishes a few further particulars concerning the form of light-curve and amplitude of the determined variation, in *Comptes rendus* (cxxxiii. pp. 324–326). When observed on the same evening, the minima of two orders were not quite identical. The form of the light-curve in the neighbourhood of the minima did not sensibly change during the observations, but a considerable degree of change has occurred about the points of maxima. A table is included showing the amplitudes of the variation observed on nineteen evenings during February, March and April, 1901, ranging from 2·0 magnitudes to zero.

ORBITS OF ALGOL VARIABLES, RR PUPPIS AND V PUPPIS.—Dr. A. W. Roberts has computed the characteristic features of the orbits of these two variables from observations secured at his private observatory, Lovedale, South Africa. Of the two variables, V Puppis is specially interesting from the fact that it is a spectroscopic binary, so that more refined measurements in the line of sight may possibly enable the absolute masses of the system to be determined.

RR Puppis.—

$$\left.\begin{array}{l}\text{R.A.} = 7\text{h. } 43\text{m. } 31\text{s.}\\ \text{Decl.} = -41^\circ\ 7'\cdot6\end{array}\right\}(1900\cdot0).$$

This star has been under observation for nearly twelve months, and some 200 measures obtained. The period adopted is

6d. 10h. 19·6m.,

and the light-curve based on this value is given, with an enlarged diagram of the part near minimum. The curve is almost identical in form with that of S Velorum. Other details are as follows:—

Limits of variation are 9·1 and 10·8 magnitude.
Duration of increasing or decreasing phase = 4h. 15m.
Stationary period at minimum = 8h. 30m.

The system thus apparently consists of two bodies, one of which is *three* times the diameter of the other. The smaller star is nearly twice as bright as the larger one, and the distance between their circumferences is about two-thirds of the radius of the orbit. The density of the system is probably not more than one-sixth that of the sun.

V Puppis.

$$\left.\begin{array}{l}\text{R.A.} = 7\text{h. } 55\text{m. } 22\text{s.} \\ \text{Decl.} = -\ 48^\circ\ 58'\cdot 4\end{array}\right\}(1900\cdot 0).$$

This star differs from the preceding one in that it consists of two bodies of about equal size and brightness. The mean period, as deduced from the light variation, is

1d. 10h. 54m. 26·7s.

The light-curve of this star is strikingly similar to that of U Pegasi, showing double and *unequal minima*, and double and *equal maxima*.

Prof. Pickering, however, from spectroscopic determinations, deduces a period of

3d. 2h. 46m.

From the peculiarity of there being no stationary period at either maximum, Dr. Roberts infers that the two component stars revolve around each other *in actual contact*. Under such conditions, both bodies would most probably undergo distortion. The value derived for the density of V Puppis is 0 07 that of the sun, the orbit being circular.

POLISH.[1]

THE lecture commenced with a description of a home-made spectroscope of considerable power. The lens, a plano-convex of 6 inches aperture and 22 feet focus, received the rays from the slit, and finally returned them to a pure spectrum formed in the neighbourhood. The skeleton of the prism was of lead; the faces, inclined at 70°, were of thick plate-glass cemented with glue and treacle. It was charged with bisulphide of carbon, of which the free surface (of small area) was raised above the operative part of the fluid. The prism was traversed twice, and the effective thickness was 5½ inches, so that the resolving power corresponded to 11 inches, or 28 cm., of CS_2. The liquid was stirred by a perforated triangular plate, nearly fitting the prism, which could be actuated by means of a thread within reach of the observer. The reflector was a *flat*, chemically silvered in front.

So far as eye observations were concerned, the performance was satisfactory, falling but little short of theoretical perfection. The stirrer needed to be in almost constant operation, the definition usually beginning to fail within about twenty seconds after stopping the stirrer. But although the stirrer was quite successful in maintaining uniformity of temperature as regards *space, i.e.* throughout the dispersing fluid, the temperature was usually somewhat rapidly variable with *time*, so that photographs requiring more than a few seconds of exposure showed inferiority. In this respect a grating is more manageable.

The lens and the faces of the prism were ground and polished (in 1893) upon a machine kindly presented by Dr. Common. The flat surfaces were tested with a spherometer, in which a movement of the central screw through 1/100000 inch could usually be detected by the touch. The external surfaces of the prism faces were the only ones requiring accurate flatness. In polishing, the operation was not carried as far as would be expected of a professional optician. A few residual pittings, although they spoil the appearance of a surface, do not interfere with its performance, at least for many purposes.

In the process of grinding together two glass surfaces, the particles of emery, even the finest, appear to act by *pitting* the glasses, *i.e.* by breaking out small fragments. In order to save time and loss of accuracy in the polishing, it is desirable to carry the grinding process as far as possible, using towards the close only the finest emery. The limit in this direction appears to depend upon the tendency of the glasses (6 inches diameter) to *seize*, when they approach too closely, but with a little care it is easy to attain such a fineness that a candle is seen reflected at an angle of incidence not exceeding 60°, measured as usual from the perpendicular.

The fineness necessary, in order that a surface may reflect and refract regularly without diffusion, viz. in order that it may appear *polished*, depends upon the wave-length of the light and upon the angle of incidence. At a grazing incidence all surfaces behave as if polished, and a surface which reflects red light pretty well may fail signally when tested with blue light at the same angle. If we consider incidences not too far removed from the perpendicular, the theory of gratings teaches that a regularly corrugated surface behaves as if absolutely plane, provided that the *wave-length* of the corrugations is less than the wave-length of the light, and this without regard to the *depth* of the corrugations. Experimental illustrations, drawn from the sister science of acoustics, were given. The source was a bird-call from which issued vibrations having a wave-length of about 1·5 cm., and the percipient was a high-pressure sensitive flame. When the bird-call was turned away, the flame was silent, but it roared vigorously when the vibrations were reflected back upon it from a plate of glass. A second plate, upon which small pebbles had been glued so as to constitute an ideally rough surface, acted nearly as well, and so did a piece of tin plate suitably corrugated. In all these cases the reflection was *regular*, the flame becoming quiet when the plates were turned out of adjustment through a very small angle. In another method of experimenting the incidence was absolutely perpendicular, the flame being exposed to both the incident and the reflected waves. It is known that under these circumstances the flame remains quiescent at the *nodes* and flares most vigorously at the *loops*. As the reflector is drawn slowly back, the flame passes alternately through the nodes and loops, thus executing a cycle of changes as the reflector moves through *half* a wave-length. The effects observed were just the same whether the reflector were smooth or covered with pebbles, or whether the corrugated tin plate were substituted. All surfaces were smooth *enough* in relation to the wave-length of the vibration to give substantially a specular reflection.

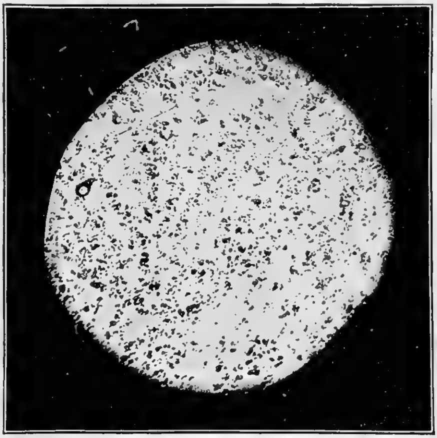


FIG. 1.

Finely ground surfaces are still too coarse for perpendicular specular reflection of the longest visible waves of light. Here the material may be metal, or glass silvered chemically on the

[1] A discourse delivered at the Royal Institution on Friday, March 29, by the Right Hon. Lord Rayleigh, F.R.S.

face subsequently to the grinding. But experiment is not limited by the capabilities of the eye; and it seems certain that a finely ground surface would be smooth enough to reflect without sensible diffusion the longest waves, such as those found by Rubens to be nearly 100 times longer than the waves of red light. An experiment may be tried with radiation from a Leslie cube containing hot water, or from a Welsbach mantle (without a chimney). In the lecture the latter was employed, and it fell first at an angle of about 45° upon a finely ground flat glass silvered in front. By this preliminary reflection, the radiation was purified from waves other than those of considerable wave-length. The second reflection (also at 45°) was alternately from polished and finely ground silvered surfaces of the same size, so mounted as to permit the accurate substitution of the one for the other. The heating-power of the radiation thus twice reflected was tested with a thermopile in the usual manner. Repeated comparisons proved that the reflection from the ground surface was about 0·76 of that from the polished surface, showing that the ground surface reflected the waves falling upon it with comparatively little diffusion. A slight rotation of any of the surfaces from their proper positions at once cut off the effect. It is probable that the device of submitting radiation to preliminary reflections from one or more merely ground surfaces might be found useful in experiments upon the longest waves.

FIG. 2

In view of these phenomena we recognise that it is something of an accident that polishing processes, as distinct from grinding, are needed at all; and we may be tempted to infer that there is no essential difference between the operations. This appears to have been the opinion of Herschel,[1] whom we may regard as one of the first authorities on such a subject. But although, perhaps, no sure conclusion can be demonstrated, the balance of evidence appears to point in the opposite direction. It is true that the same powders may be employed in both cases. In one experiment a glass surface was polished with the same emery as had been used effectively a little earlier in the grinding. The difference is in the character of the backing. In grinding, the emery is backed by a hard surface, *e.g.* of glass, while during the polishing the powder (mostly rouge in these experiments) is imbedded in a comparatively yielding substance, such as pitch. Under these conditions, which preclude more than a moderate pressure, it seems probable that no pits are formed by the breaking out of fragments, but that the material is worn away (at first, of course, on the eminences) almost molecularly.

The progress of the operation is easily watched with a microscope, provided, say, with a ½-inch object-glass. The first few minutes suffice to effect a very visible change. Under the microscope it is seen that little facets, parallel to the general plane of the surface, have been formed on all the more prominent eminences.[1] The facets, although at this stage but a very small fraction of the whole area, are adequate to give a sensible specular reflection, even at perpendicular incidence. On one occasion five minutes' polishing of a rather finely ground glass surface was enough to qualify it for the formation of interference bands, when brought into juxtaposition with another polished surface, the light being either white or from a soda flame; so that in this way an optical test can be applied almost before the polishing has begun.[2]

As the polishing proceeds, the facets are seen under the microscope to increase both in number and in size, until they occupy much the larger part of the area. Somewhat later the

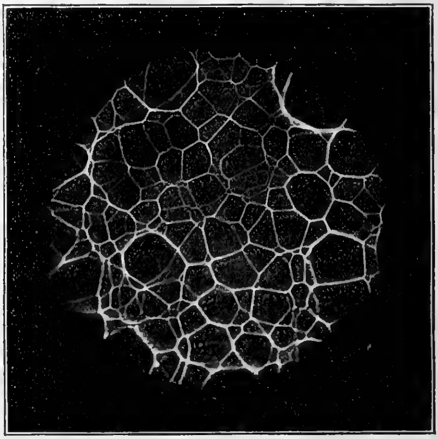


FIG. 3

parts as yet untouched by the polisher appear as pits, or spots, upon a surface otherwise invisible. Fig. 1 represents a photograph of a surface at this stage taken with the microscope. The completion of the process consists in rubbing away the whole surface down to the level of the deepest pits. The last part of the operation, while it occupies a great deal of time and entails further risk of losing the "truth" of the surface, adds very little to the effective area or to the intensity of the light regularly reflected or refracted.

Perhaps the most important fact taught by the microscope is that the polish of individual parts of the surface does not improve during the process. As soon as they can be observed at all, the facets appear absolutely structureless. In its subsequent action the polishing tool, bearing only upon the parts already polished, extends the boundary of these parts, but does not enhance their quality. Of course, the mere fact that no structure can be perceived does not of itself prove that pittings may not be taking place of a character too fine to be shown by

[1] "Enc. Met.," Art. Light, p. 477, 1830: "The intensity and regularity of reflection at the external surface of a medium is found to depend, not merely on the nature of the medium, but very essentially on the degree of smoothness and polish of its surface. But it may reasonably be asked how any regular reflection can take place on a surface polished by art, when we recollect that process of polishing is, in fact, nothing more than grinding down large asperities into smaller ones by the use of hard gritty powders, which, whatever degree of mechanical comminution we may give them, are yet vast masses, in comparison with the ultimate molecules of matter, and their action can only be considered as an irregular tearing up by the roots of every projection that may occur in the surface. So that, in fact, a surface artificially polished must bear somewhat of the same kind of relation to the surface of a liquid, or a crystal, that a ploughed field does to the most delicately polished mirror, the work of human hands."

[1] The interpretation is facilitated by a thin coating of aniline dye which attaches itself mainly to the hollows.

[2] With oblique incidence, as in Talbot's experiments (see *Phil. Mag.*, xxviii. p. 191, 1889), achromatic bands may be observed from a surface absolutely unpolished, but this disposition would not be favourable for testing purposes.

a particular microscope or by any possible microscope. But so much discontinuity, as compared with the grinding action, has to be admitted in any case that one is inevitably led to the conclusion that in all probability the operation is a molecular one, and that no coherent fragments containing a large number of molecules are broken out. If this be so, there would be much less difference than Herschel thought between the surfaces of a polished solid and of a liquid.

Several trials have been made to determine how much material is actually removed during the polishing of glass. In one experiment a piece 6 inches in diameter, very finely ground, was carefully weighed at intervals during the process. Losses of ·070, ·032, ·045, ·026, ·032 gm. were successively registered, amounting in all to ·205 gm. Taking the specific gravity of the glass as 3, this corresponds to a thickness of $3 \cdot 6 \times 10^{-4}$ cm., or to about 6 wave-lengths of mean light, and it expresses the distance between the original *mean* surface and the final plane. But the polish of this glass, though sufficient for most practical purposes, was by no means perfect. Probably the 6 wave-lengths would have needed to be raised to 10 in order to satisfy a critical eye. It may be interesting to note for comparison that, in the grinding, one charge of emery, such as had remained suspended in water for seven or eight minutes, removed a thickness of glass corresponding to 2 wave-lengths.

In other experiments the thickness removed in polishing was determined optically. A very finely ground disc was mounted in the lathe and polished locally in rings. Much care was needed to obtain the desired effect of a ring showing a continuously increasing polish from the edges inwards. To this end it was necessary to keep the polisher (a piece of wood covered with resin and rouge) in constant motion, otherwise a number of narrow grooves developed themselves.

The best ring was about half an inch wide. When brought into contact with a polished flat and examined at perpendicular incidence with light from a soda flame, the depression at its deepest part gave a displacement of three bands, corresponding to a depth of $1\frac{1}{2}\lambda$. On a casual inspection this central part appeared well polished, but examination under the microscope revealed a fair number of small pits. Further working increased the maximum depth to $2\frac{1}{2}\lambda$, when but very few pits remained. In this case, then, polish was effected during a lowering of the mean surface through 2 or 3 wave-lengths, but the grinding had been exceptionally fine.

It may be well to emphasise that the observations here recorded relate to a *hard* substance. In the polishing of a soft substance, such as copper, it is possible that material may be loosened from its original position without becoming detached. In such a case pits may be actually filled in, by which the operation would be much quickened. Nothing suggestive of this effect has been observed in experiments upon glass.

Another method of operating upon glass is by means of hydrofluoric acid. Contrary to what is generally supposed, this action is extremely regular, if proper precautions are taken. The acid should be weak, say one part of commercial acid to two hundred of water, and it should be kept in constant motion by a suitable rocking arrangement. The parts of the glass not intended to be eaten into are, as usual, protected with wax. The effect upon a polished flat surface is observed by the formation of Newton's rings with soda light. After perhaps three-quarters of an hour, the depression corresponds to half a band, *i.e.* amounts to $\frac{1}{4}\lambda$, and it appears to be uniform over the whole surface exposed. Two pieces of plate glass, 3 inches square, and flat enough to come into fair contact all over, were painted with wax in parallel stripes and submitted to the acid for such a time, previously ascertained, as would ensure an action upon the exposed parts of $\frac{1}{4}\lambda$. After removal of the wax, the two plates, crossed and pressed into contact so as to develop the colours, say of the second order, exhibited a chess-board pattern. Where two uncorroded, or where two corroded, parts are in contact, the colours are nearly the same, but where a corroded and an uncorroded surface overlap, a strongly contrasted colour is developed. The combination lends itself to lantern projection, and the pattern upon the screen [shown] is very beautiful, if proper precautions are taken to eliminate the white light reflected from the first and fourth surfaces of the plates.

In illustration of the action of hydrofluoric acid, photographs [1] were shown of interference bands as formed by soda light between glass surfaces, one optically flat and the other ordinary plate, upon which a drop of dilute acid had been allowed to stand (Fig. 2) Truly plane surfaces would give bands straight, parallel and equidistant.

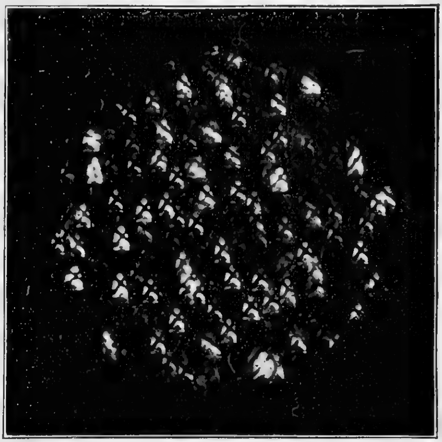


FIG. 4.

Hydrofluoric acid has been employed with some success to correct ascertained errors in optical surfaces. But while improvements in actual optical performance have been effected, the general appearance of a surface so treated is unprepossessing. The development of latent scratches has been described on a former occasion.[2]

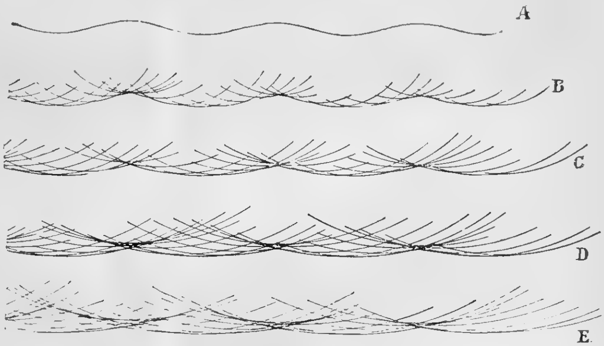


FIG. 5.

A second obvious application of hydrofluoric acid has hitherto been less successful. If a suitable stopping could be

[1] The plates were sensitised in the laboratory with cyanine.
[2] *Proc.* Roy. Inst., March, 1893.

found by which the deeper pits could be protected from the action, corrosion by acid could be used in substitution for a large part of the usual process of polishing.

In connection with experiments of this sort, trial was made of the action of the acid upon finely ground glass, such, for example, as is used as a backing for stereoscopic transparencies, and very curious results were observed. For this purpose the acid may conveniently be used much stronger, say one part of commercial acid to ten parts of water, and the action may be prolonged for hours or days. The general appearance of the glass after treatment is smoother and more translucent, but it is only under the microscope that the remarkable changes which the surface has undergone become intelligible. Fig. 3 is from a photograph taken in the microscope, the focus being upon the originally ground surface itself. The whole area is seen to be divided into cells. These cells increase as the action progresses, the smaller ones being, as it were, eaten up by the bigger. The division lines between the cells are *ridges*, raised above the general level, and when seen in good focus appear absolutely sharp. The general surface within the cells shows no structure, being as invisible as if highly polished.

That each cell is, in fact, a concave lens, forming a separate image of the source of light, is shown by slightly screwing out the object-glass. Fig. 4 was taken in this way from the same surface, the source of light being the flame of a paraffin lamp, in front of which was placed a cross cut from sheet-metal.

The movement required to pass from the ridge to the image of the source, equal to the focal length (f) of the lens, may be utilised to determine the depth (t) of a cell. In one experiment the necessary movement was ·005 inch. The semi-aperture (y) of the "lens" was ·0015 inch, whence by the formula $y^2=ft$, we find $t=\cdot 00045$ inch. This represents the depth of the cell, and it amounts to about 8 wave-lengths of yellow light.

The action of the acid seems to be readily explained if we make the very natural supposition that it eats in everywhere, at a fixed rate, normally to the actual surface. If the amount of the normal corrosion after a proposed time be known, the new surface can be constructed as the "envelope" of spheres having the radius in question and centres distributed over the old surface. Ultimately, the new surface becomes identified with a series of spherical segments having their centres at the deeper pits of the original surface. The construction is easily illustrated in the case of two dimensions. In the figure (Fig. 5) A is supposed to be the original surface; B, C, D, E surfaces formed by corrosion, being constructed by circles having their centres on A. In B the ridges are still somewhat rounded, but they become sharp in D and E. The general tendency is to sharpen elevations and to smooth off depressions.

THE FUNCTIONS OF A UNIVERSITY.[1]

THE word University has borne many significations; and, indeed, its functions are various, and the signification attached to the word has depended on the particular point of view taken at the time. An eminent German, who visited me some years ago, made the remark after seeing University College:—"Aber, lieber Herr College, University College ist eine kleine Universität." So it is; for it fulfils most of the functions of the most successful Universities in the world. And why is this? Because the traditions of University College have always been, that it is not merely a place where known facts and theories should be administered in daily doses to young men and young women, but that the duties of the professors, assistant-professors, teachers and advanced students is to increase knowledge. That is the chief function of a University—to increase knowledge. But it is not the only one.

A University has always been regarded as a training school for the "learned professions," *i.e.* for theology, law and medicine. The terms of our charter have excluded the first of these branches of knowledge. Founded as it was in the '20's, when admission to Oxford or Cambridge involved either belief in the tenets of the Church of England or insincerity, it was not possible to provide courses in theology which should be acceptable to Nonconformists, Jews and others who desired education. On the whole, it appears to me better that a subject about which so much difference of opinion exists should be taught in a separate institution. There are many branches of knowledge which can be adequately discussed without intruding into any sphere of religious controversy; and, indeed, it would be difficult, I imagine, to treat mathematics or chemistry from a sectarian standpoint. I at least have never tried. There are subjects which may be placed on the border-line, for example, philosophy; but such subjects, and they are few in number, might well form part of the curriculum of the theological college, if thought desirable. It is a thousand pities that instead of founding King's College a theological college had not been established in the immediate neighbourhood of University College; it would have strengthened us, and it would have tended, too, to the advantage of the Church of England. However, what is done can't be undone; and let us wish all prosperity to our sister College, and a long and a useful life. We are now friends, and have been friends for many years. May that friendship long continue!

Dismissing the faculty of theology, therefore, as out of our power, as well as beyond our wishes, let us turn to the remaining two learned professions. University College, I believe, was the first place in England where a systematic legal education could be obtained. Our chairs of Roman law, constitutional law and jurisprudence were the first to be established in England, although such chairs had for long been known on the Continent, and in Scotland. "Imitation is the sincerest flattery," and in the fulness of time the Inns of Court started a school of their own. Our classes, which used to be crowded, dwindled, and our law-school is certainly not our strongest feature. I am not sufficiently acquainted with English legal education to pronounce an opinion as to whether methods of training as they at present exist in England are the most effective; I have heard rumours that they are not. That must be left to specialists to decide. But arguing from the experience of another faculty, in which the apprenticeship system once existed, and which has changed that system with a view to reform, and judging, too, from the experience abroad and in Scotland, I venture to think that some improvement in legal education is possible. If that opinion is correct, it is surely not too much to hope that the claims of University College may be considered as having made the first attempt to systematise legal education in England.

The faculty of medicine has existed in a flourishing state since the inception of University College. Not long after the College was built, the Hospital buildings, of which we have the last unsightly remains still before our eyes, were erected. One of my predecessors on a similar occasion to this has given you an entrancing account of the early history of this side of the College, and has discoursed on the eminent men who filled the chairs in the medical faculty. Here young men whose intention it is to enter the medical profession are trained; they now receive five years' instruction in the various branches of knowledge bearing on their important calling. I would point out that this function of a University is professedly a technical one—the training of medical men. True, many researches have been made by the eminent men who have held chairs in this faculty; but that is not the primary duty of such men; their duty is to train others to exercise a profession. If they advance their subject in doing so, so much the better; it increases the fame of the school, it imparts enthusiasm to their students, and in many cases their discoveries have been of unspeakable benefit to the human race. In a certain sense, every medical man is an investigator; the first essential is that he shall be able to make a correct diagnosis; the next, that he shall prescribe correct treatment. But novelty is not essential; few men evolve new surgical operations or introduce new remedies, and though we have in the past had not a few such, they are not essential for a successful medical school, the object of which is to train good practical working physicians and surgeons. The teaching staff of the medical faculty must of necessity be almost all engaged in practice, and, indeed, it would be unfortunate for their students if they were merely theoretical teachers. Let me again recapitulate my point; the medical faculty is essentially a technical faculty; the hospital is its workshop.

In England, of recent years, schools of engineering have been attached to the Universities. Abroad and in America they are separate establishments, and are sometimes attached to large engineering shops, where the pupils pursue their theoretical and practical studies together, taking the former in the morning, the latter in the afternoon. Here again the subject is a professional

[1] Oration delivered at University College, London, on June 6, by Prof. W. Ramsay, F.R.S.

one. The object of the student is to become a practical engineer, and all his work is necessarily directed to that end. Like other workers in different fields, his aim is the acquisition and utilisation of "power," but in his case it is his object to direct mechanical and electrical power so as to add to the convenience of the public. A machine is an instrument for converting heat or electrical energy into what is termed "kinetic energy," and it is with the laws and modes of this conversion that he has to deal. Such abstract sciences as chemistry, physics and geology, therefore, are studied as means to an end, not for their own sakes. They afford him a glimpse of the principles on which his engineering practice is based; and mathematics is essential in order that he may be able to apply physical principles to the practical problems of his profession.

We see, then, that a University, as it at present exists, provides, or may provide, technical instruction for theologians, for lawyers, for medical men and for engineers. It is, in fact, an advanced technical school for these subjects.

But it is more, and I believe that its chief function lies in the kind of work which I shall attempt now to describe. The German Universities possess what they term a "philosophical faculty"; and this phrase is to be accepted in the derivational meaning of the word—a faculty which befriends wisdom or learning. The watchword of the members of this faculty is research; the searching out the secrets of nature, to use a current phrase, or the attempt to create new knowledge. The whole machinery of the philosophical faculty is devised to achieve this end; the selection of the teachers, the equipment of the laboratories and libraries, the awarding of the degrees.

What are the advantages of research? Much is heard nowadays regarding the necessity of State-provision for its encouragement, and the Government places at the disposal of the Royal Society a sum of no less than 4000*l*. a year, which is distributed in the form of grants to applicants who are deemed suitable by committees appointed to consider their claims to assistance.

There are two views regarding the advantage of research which have been held. The first of these may be termed the utilitarian view. You all know the tale of the man of science who was asked the use of research and who parried with the question—What is the use of a baby? Well, I imagine that one school of political economists would oppose the practice of child-murder on the ground that potentially valuable property was being destroyed. These persons would probably not be those who stood to the baby in a parental relation. Nor are the most successful investigators those who pursue their inquiries with the hope of profit, but for the love of them. It is, however, a good thing, I believe, that the *profanum vulgus* should hold the view that research is remunerative to the public—as some forms of it undoubtedly are.

The second view may be termed the philosophical one. It is one held by lovers of wisdom in all its various forms. It explains itself, for the human race is differentiated from the lower animals by the desire which it has to know "why." You may have noticed, as I have, that one of the first words uttered by that profound philosopher, a small child, is "why." Indeed, it becomes wearisome by its iteration. We are the superiors of the brutes in that we can hand down our knowledge. It may be that some animals also seek for knowledge; but at best it is of use to themselves alone; they cannot transmit it to their posterity, except, possibly, by the way of hereditary faculties. We, on the contrary, can write and read; and this places us, if we like, in the possession of the accumulated wisdom of the ages.

Now the most important function, I hold, of a University is to attempt to answer that question, "why?" The ancients tried to do so; but they had not learned that its answer must be preceded by the answer to the question, "how?" and that in most cases—indeed in all—we must learn to be contented with the answer to "how?" The better we can tell *how* things are, the more nearly shall we be able to say *why* they are.

Such a question is applicable to all kinds of subjects; to what our forerunners on this earth did; how they lived; if we go even further back, what preceded them on the earth. The history of these inquiries is the function of geology, palæontology and palæontological botany; it is continued through archæology, Egyptian and Assyrian, Greek and Roman; it evolves into history, and lights are thrown on it by languages and philology; it dovetails with literature and economics. In all these, research is possible; and a University should be equipped for the successful prosecution of inquiries in all such branches.

Another class of inquiries relates to what we think and how we reason; and here we have philosophy and logic. A different branch of the same inquiry leads us to mathematics, which deals with spatial and numerical concepts of the human mind, geometry and algebra. By an easy transition we have the natural sciences; those less closely connected with ourselves as persons, but intimately related to our surroundings. Zoology and botany, anatomy, physiology and pathology deal with living organisms as structural machines, and they are based on physics and chemistry, which are themselves dependent on mathematics.

Such inquiries are worth making for their own sakes. They interest a large part of the human race, and not to feel interested in them is to lack intelligence. The man who is content to live from day to day, glad if each day will but produce him food to eat and a roof to sleep under, is but little removed from an uncivilised being. For the test of civilisation is *prevision*; care to look forward; to provide for to-morrow; the to-morrow of the race, as well as the to-morrow of the individual; and he who looks furthest ahead is best able to cope with nature, and to conquer her.

The investigation of the unknown is to gather experience from those who have lived before us, and to secure knowledge for ourselves and for those who will succeed us. I see, however, that I am insensibly taking a utilitarian view; I by no means wish to exclude it, but the chief purpose of research must be the acquisition of knowledge, and the second its utilisation.

I will try to explain why this is so, and here you must forgive me if I cite well-known and oft-quoted instances.

If attempts were made to discover only useful knowledge (and by useful I accept the vulgar definition of profitable, *i.e.* knowledge which can be directly transmitted into its money equivalent) these attempts would, in many, if not in most, cases fail of their object. I do not say that once a principle has been proved and a practical application is to be made of it that the working out of the details is not necessary. But that is best done by the practical man, be he the parson, the doctor, the engineer, the technical electrician or the chemist, and best of all on a fairly large scale. If, however, the practical end is always kept in view, the chances are that there will be no advance in principles. Indeed, what we investigators wish to be able to do, and what in many cases we can do, although perhaps very imperfectly, is to prophesy, to foretell what a given combination of circumstances will produce. The desire is founded on a belief in the uniformity of nature; on the conviction that what has been will again be, should the original conditions be reproduced. By studying the consequences of varying the conditions our knowledge is extended; indeed, it is sometimes possible to go so far as to predict what will happen under conditions, all of which have never before been seen to be present together.

When Faraday discovered the fact that when a magnet is made to approach a coil of wire an electric current is induced in that wire, he made a discovery which at the time was of only scientific interest. That discovery has resulted in electric light, electric traction and the utilisation of electricity as a motive power; the development of a means of transmitting energy, of which we have by no means seen the end; nay, we are even now only at its inception, so great must the advance in its utilisation ultimately become.

When Hofmann set Perkin as a young student to investigate the products of oxidation of the base aniline, produced by him from coal-tar, it would have been impossible to have predicted that one manufactory alone would possess nearly 400 large buildings and employ 5000 workmen, living in its own town of 25,000 inhabitants, all of which is devoted to the manufacture of colours from aniline and other coal-tar products. In this work alone at least 350 chemists are employed, most of whom have had a University training.

Schönbein, a Swiss schoolmaster interested in chemistry, was struck by the action of nitric acid on paper and cotton. He would have been astounded if he had been told that his experiments would have resulted in the employment of his nitro-celluloses in colossal quantity for blasting, and for ordnance of all kinds, from the 90-ton gun to the fowling-piece.

But discoveries such as these, which lead directly to practical results, are yet far inferior in importance to others in which a general principle is involved. Joule and Robert Mayer, who proved the equivalence of heat and work, have had far more influence on succeeding ages than even the discoverers above mentioned, for they have imbued a multitude of minds with a correct understanding of the nature of energy and the possibility of converting it economically into that form in which it is most directly useful for the purpose in view. They have laid the basis of reasoning for *machines;* and it is on machines, instruments for converting unavailable into available energy, that the prosperity of the human race depends.

You will see from these instances that it is in reality "philosophy" or a love of wisdom which, after all, is most to be sought after. Like virtue, it is its own reward; and as we all hope is the case with virtue too, it brings other rewards in its train, not, be it remarked, always to the philosopher, but to the race. Virtue, pursued with the direct object of gain, is a poor thing; indeed, it can hardly be termed virtue if it is dimmed by a motive. So philosophy, if followed after for profit, loses its meaning.

But I have omitted to mention another motive which makes for research; it is a love of pleasure. I can conceive no pleasure greater than that of the poet—the maker—who wreathes beautiful thoughts with beautiful words; but next to this I would place the pleasure of discovery, in whatever sphere it be made. It is a pleasure, not merely to the discoverer, but to all who can follow the train of his reasoning. And after all, the pleasure of the human race, or of the thinking portion of it, counts for a good deal in this life of ours.

To return. Attempts at research, guided by purely utilitarian motives, generally fail in their object, or at least are not likely to be so productive as research without ulterior motive. I am strengthened in this conclusion by the verdict of an eminent German who has himself put the principle into practice; who after following out a purely theoretical line of experiment, which at first appeared remote from profit, has been rewarded by its remunerative utilisation. He remarked, incidentally, that the professors in polytechnika—(what we should term technical colleges, intended to prepare young men for the profession of engineering and technical chemistry)—were less known for their influence on industry than University professors. The aim is different in the two cases; the polytechnika train men for a profession, the philosophical faculty of German Universities aims at imparting a love of knowledge; and, as a matter of fact, the latter *pay* in their influence on the prosperity of the nation better than the former. And this brings me to the fundamental theme of my oration. It is this:—That the best preparation for success in any calling is the training of the student in methods of research. This should be the goal to be clearly kept in view by all teachers in the philosophical faculties of Universities. They should teach with this object:—to awaken in their students a love of their subject and a consciousness that if he persevere, he, too, will be able to extend its bounds.

Of course, it is necessary for the student to learn, so far as is possible, what has already been done. I would not urge that a young man should not master, or at all events learn, a great deal of what has been already discovered before he attempts to soar on his own wings. But there is all the difference in the world between the point of view of the student who reads in order to qualify for an examination, or to gain a prize or a scholarship, and the student who reads because he knows that thus he will acquire knowledge which may be used as a basis of new knowledge. It is that spirit in which our Universities in England are so lamentably deficient; it is that spirit which has contributed to the success of the Teutonic nations, and which is beginning to influence the United States. For this condition of things our examinational system is largely to blame; originally started to cure the abuses of our Civil Service, it has eaten into the vitals of our educational system like a canker, and it is fostered by the further abuse of awarding scholarships as the results of examinations. The pauperisation of the richer classes is a crying evil; it must some day be cured. Let scholarships be awarded to those who need them, not to those whose fathers can well afford to pay for the education of their children. "Pot-hunting" and philosophy have absolutely nothing in common.

It follows that the teachers in the philosophical faculty should be selected only from those who are themselves contributing to the advancement of knowledge; for if they have not the spirit of research in them, how shall they instil it into others? It is our carelessness in this respect (I do not speak of University College, which has always been guided by these principles, but of our country as a whole) which has made us so backward as compared with some other nations. It is this which has made the vast majority of our statesmen so careless, because so ignorant, of the whole frame of mind of the philosopher, and which has made it possible for a man high in the political estimation of his countrymen to address on a recent occasion the remarks which he did to graduates of our University. It is true that one of the functions of a University is to "train men and women fit for the manifold requirements of the Empire;" that we should all heartily acknowledge; but no man who has any claim to University culture can possibly be contented if the University does not annually produce much work of research. It is its chief excuse for existence; a University which does not increase knowledge is no University; it may be a technical school, it may be an examining board, it may be a coaching establishment, but it has no claim to the name University. The best way of fitting young men for the manifold requirements of the Empire is to give them the power of advancing knowledge.

It may be said that many persons are incapable of exhibiting originality. I doubt it. There are many degrees of originality, as there are many degrees in rhyming, from the writer of doggerel to the poet, or many degrees of musical ear, from the man who knows two tunes, the tune of "God Save the King" and the *other* tune, to the accomplished musician. But in almost all cases, if caught young the human being can be trained, more or less, and, as a matter of fact, natural selection plays its part. Those young men and women who have no natural aptitude for such work—and they are usually known by the lack of interest which they take in it—do not come to the University. My experience is that the majority, or at least a fair percentage of those who do come, possess germs of the faculty of originating, germs capable of development, in many instances, to a very high degree. It is such persons who are of most value to the country; it is from them that advance in literature and in science is to be expected, and many of them will contribute to the commercial prosperity of the country. We hear much nowadays o. technical education; huge sums of money are being annually expended on the scrappy scientific education in evening classes of men who have passed a hard day in manual labour, men who lack the previous training necessary to enable them to profit by such instruction. It may be that it is desirable to provide such intellectual relaxation; I even grant that such means may gradually raise the intellectual level of the country; but the investment of money in promoting such schemes is not the one likely to bear the most immediate and remunerative fruit. The Universities should be the technical schools; for the man who has learned to investigate can bring his talents to bear on any subject brought under his notice, and it is on the advance, and not the mere dissemination, of knowledge that the prosperity of a country depends. To learn to investigate requires a long and hard apprenticeship; the power cannot be acquired by an odd hour spent now and again; it is as difficult to become a successful investigator as a successful barrister or doctor, and it requires at least as hard application and as long a period of study.

I do not believe that it is possible for young men or women to devote sufficient time during the evening to such work. Those who devote their evening hours to study and investigation do not bring fresh brains to bear on the subject; they are already fatigued by a long day's work; and, moreover, it is the custom in most of the colleges which have evening classes to insist upon their teachers doing a certain share of day work; they, too, are not in a fit state to direct the work of their pupils or to make suggestions as to the best method of carrying it out. Moreover, the official evening class is from 7 to 10 o'clock, and for investigation in science a spell of three hours at a time is barely sufficient to carry out successfully the end in view; indeed, an eight hours' day might profitably be lengthened into a twelve hours' day, as it not infrequently is. It is heartrending in the middle of some important experiment to be obliged to close and postpone it till a future occasion, when much of the work must necessarily be done over again.

These are some of the reasons why I doubt whether University education, in the philosophical faculty at least, can be successfully given by means of evening classes.

Although my work has lain almost entirely in the domain of science, I should be the last man not to do my best to encourage research in the sphere of what is generally called "arts." In Germany of recent years a kind of institution has sprung up which is termed a *Seminar*. The word may be translated a "literary laboratory." I will endeavour to give a short sketch on the way in which these literary laboratories are conducted. After the student has attended a course of lectures on the subjects to which he intends to devote himself and is ripe for research, he enters a Seminar, in which he is provided with a library, paper, pens and ink and a subject. The method of using the library is pointed out to him, and he is told to read books which bear on the particular subject in question; he is made to collate the information which he gains by reading, and to elaborate the subject which is given him. Naturally his first efforts must be crude, but "*c'est le premier pas qui coûte*." It probably costs him blame at the hands of his instructor; after a few unsuccessful efforts, however, if he has any talent for the particular investigation to which he has devoted himself, his efforts improve and at last he produces something respectable enough to merit publication. Thus he is exposed to the criticism of those best competent to judge, and he is launched in what may be a career in historical, literary or economic research.

Such a Seminar is carried on in philological and linguistic studies, in problems of economy involving statistics, in problems of law involving judicial decision, and of history in which the relations between the development of the various phases in the progress of nations is traced. The system is borrowed from the well-known plan of instruction in a physical or chemical laboratory. Experiments are made in literary style. These experiments are subjected to the criticism of the teacher, and thus the investigator is trained. But it may be objected that the youths who frequent our Universities have not a sufficient knowledge of facts connected with such subjects to be capable of at once entering on a training of this kind. That may be so; if it is the case, our schools must look to it that they provide sufficient training. Even under present circumstances, however, I do not think I am mistaken in supposing that a young man or woman who enters a University at the age of eighteen years with the intention of spending three years in literary or historical studies will not at the end of the second year be more benefited by a course at the Seminar, even though it should result in no permanent addition to literature or history, than if he were to spend his time in mere assimilation. It is not the act of gaining knowledge which profits, it is the power of using it, and while in order to use knowledge it is necessary to gain it, yet a training in the method of using knowledge is much more important and profitable than a training in the method of gaining it. I do not know whether there exists in this country a single example of the continental Seminar; there was some talk of founding such a literary laboratory in University College, but, as usual, the attempt was frustrated by a lack of funds; the attempt would also have been frustrated by the requirements of the present system of examination in the University of London; but there is, fortunately, good hope of changing that system and of developing the minds of students on those lines which have proved so fruitful where they have been systematically followed.

Many, I suppose, who are at present listening to me would be disappointed were I not to refer to the functions of a University with reference to examinations. A long course of training, lasting now for the best part of seventy years, has convinced the population of London that the chief function of a University is to examine. Believe me, the examination should play only a secondary part in the work of a University. It is necessary to test the acquirements of the students whom the teachers have under their charge, but the examination should play an entirely subordinate part. To aim at success in examinations is, unfortunately, too often the goal which the young student aims at, but it is one which all philosophical teachers deprecate. To infuse into his pupils a love of the subject which both are at the same time teaching and learning is the chief object of an enthusiastic teacher; there should be an atmosphere of the subject surrounding them—an umbra—perhaps I should call it an aura; for it should exert no depressing influence upon them. The object of both classes of students (for I count the teacher a student) should be to do their best to increase knowledge of the subject on which they are engaged. That this is possible many teachers can testify to by experience; and it is the chief lesson learned by a sojourn in a German laboratory. Where each student is himself engaged in research, interest is taken by the students in each others' work; numerous discussions are raised regarding each questionable point; and the combined intelligence of the whole laboratory is focussed on the elucidation of some difficult problem. There is nothing more painful to witness than a dull and decorous laboratory, where each student keeps to his own bench, does not communicate with his fellow-students, does not take an interest in their work and expects them to manifest no interest in his. It is only by friction that heat can be produced, and heat, by increasing the frequency of vibration, results, as we know, in light.

The student should look forward to his examination, not as a solemn ordeal which he is compelled to go through with the prospect of a degree should he be successful, but as a means of showing his teacher and his fellows how much he has profited by the work which he has done; those who pursue knowledge in this spirit and those, be it remarked, who examine in this spirit will look forward to examination with no apprehension; not, perhaps, with joy, for after all it is a bore to be examined and perhaps a still greater bore to examine, but it is a necessary step for the student in gaining self-assurance and the conviction of having profited by his exertions, and for the teacher as a means of ensuring that his instruction has not been profitless to his student. In this connection I cannot refrain from remarking that that genius for competition which has overridden our nation of England appears to me to be misplaced. Far too much is thought of the top man; very likely the second or even the tenth, or it may be the fiftieth, has a firmer grasp of his subject and in the long run would display more talent. Let us take comfort, however, in the thought that the day of examinations, for the sake of examinations, is approaching an end.

It may surprise many to learn that the suggestion that in England teachers do not usually examine their own pupils for degrees is, abroad, received in a spirit of surprise not unmixed with incredulity. Americans and Germans to whom I have mentioned this state of matters cannot realise that the teacher is not considered fit to be trusted to examine his own pupils, and, singular to state, they maintain that no one else can possibly do so with any attempt at fairness; it appears to them, as it appears to me, an altogether untenable position to hold that a man selected to fill an important professorship, after many years' trial in a junior position, should be suspected of such (shall I say) ambiguous ideas regarding common honesty that he will always arbitrate unfairly in favour of his own pupils. Such a supposition is an insult to the professor, and the exclusion of the teacher elevates examination to the position of a fetish; it is that, together with the spirit of emulation and competition, which has done so much to ruin our English education. The idea of competitive examination is so ingrained in the minds of Englishmen that it is difficult for them to realise that the object of a University is, not primarily to examine its pupils, but to teach them to teach themselves; and also they have still to acquire the conviction that students should be found, not merely among the *alumni* of the University, but also among all members of the staff. The spirit which should prevail with us should be the spirit of gaining knowledge—gaining knowledge, not for the satisfaction of one's own sense of acquisitiveness, but in order to be able to increase the sum total of what is known. All should work together, senior and junior staff, graduates and undergraduates, in order to diminish man's ignorance.

To sum up. As it exists at present, a University is a technical school for theology, law, medicine and engineering. It ought to be also a place for the advancement of knowledge, for the training of philosophers, of those who love wisdom for its own sake; and while as a technical school it exercises a useful function in preparing many men and women for their calling in life, its philosophical faculty should impart to those who enter its halls that faculty of increasing knowledge which cannot fail to be profitable, not only to the intellect of the nation, but also to its industrial prosperity. I regard this as the chief function of a University.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE doctorates conferred by American Universities during the academic year lately concluded, and the subjects of the theses presented, are summarised in *Science* of August 2. The degree of doctor of philosophy was conferred on 253 candidates—a number which is probably greater than that of any previous year. Of these degrees 122 were given for subjects belonging to the humanities, and 131 for science subjects. Harvard and Yale have this year given as many degrees in the sciences as in the humanities, whereas in previous years the humanities have predominated, as the sciences have at Johns Hopkins and Cornell. There was a relative excess in the number of degrees in chemistry at Johns Hopkins; in physics at Cornell and Johns Hopkins; in mathematics at Yale; in zoology at Chicago; in psychology at Clark, Yale and Harvard, and in geology at Johns Hopkins and Harvard. Taking all the Universities together, the six subjects in which the most doctorates were conferred are:—chemistry, 28; physics, 23; mathematics, 18; zoology, 15; psychology, 13; geology, 10. The remaining 24 degrees were divided among twelve sciences.

SPECIAL courses of evening lectures for teachers and advanced students have been arranged by the London Technical Education Board at University College, King's College and Bedford College. The courses of instruction will afford an opportunity to students who can study only in the evenings to obtain instruction in well-equipped laboratories, and will make available to evening students the same advantages as are enjoyed by University day students, but they are only intended for those who are practically engaged during the day in some trade, business or occupation. At University College, Prof. J. A. Fleming, F.R.S., will give a course of ten lectures, followed by laboratory demonstrations, on advanced electrical measurements. Prof. Carus Wilson will give a course of lectures on the electric motor, with special reference to its employment in electric tram-car traction. In connection with these two courses, a special course of about twenty lectures on alternating currents will be given at King's College by Prof. E. Wilson, followed by a class for practical work. Prof. D. S. Capper will give about twenty lectures upon steam and gas engines, accompanied by laboratory work, and Prof. J. D. Cormack will lecture upon properties and testing of materials of construction. A course of civil engineering will also be given by Prof. Robinson. A course of twelve lectures on the recent developments of chemical theory will be given, under the direction of Prof. Ramsay, at University College, and a course of eight lectures dealing with the methods of spectroscopy, especially in connection with the photography of the spectrum, will be given by Mr. E. C. C. Baly. Saturday morning courses have been arranged for teachers; they include lectures on the teaching of mathematics, by Prof. Hudson, F.R.S.; physics, by Prof. W. Grylls Adams, F.R.S., and Mr. S. A. F. White; practical physiology, by Prof. Halliburton, F.R.S.; and a course on the teaching of elementary chemistry, by Mr. H. Crompton, at Bedford College.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 5.—M. Fouqué in the chair.—On Poisson's theorem and on a recent theorem of M. Buhl, by M. Paul Appell. The theorem of Buhl is a particular case of Poisson's theorem.—The law of pressures in cannon, by M. Vallier.—New method of preparing aniline and its analogues, by MM. Paul Sabatier and J. B. Senderens. A mixture of hydrogen and nitrobenzene vapour is passed over reduced copper kept at a temperature of from 300°-400° C., the yield of aniline being nearly theoretical. If nickel is employed instead of the copper, the reaction goes farther even at 200°, benzene and ammonia being produced.—On the luminous variation of the planet Eros; curves of light; amplitude of the variation, by M. Ch. André.—On the infinitely small deformation of a spherical elastic envelope, by MM. Eugène and Francois Cosserat.—On a relation which probably exists between the characteristic angle of deformation of metals and the Newtonian coefficient of restitution, by M. G. Gravaris. The characteristic angle of deformation (a), and the Newtonian constant of restitution (e), appear to be related according to the equation $\pi e = 2a$.—Critical study of the general theory of mechanisms, by M. G. Kœnigs.—On disruptive discharge in electrolytes, by M. K. R. Johnson.—Remarks on a communication of MM. A. Broca and Turchini.—The electric capacity of the human body, by M. G. de Metz. It follows from the experiments described that it is illusory to compare the electric capacity of the human body with that of an ellipsoidal conductor. The same person may possess several capacities according to the conditions under which he is placed. The average figure found is about 0·00011 microfarad.—The difference of potential and the deadening of the electric spark with oscillatory character, by M. F. Beaulard.—On the transmission of Hertzian waves through conducting liquids, by M. Charles Nordmann. For the liquids studied (solutions of sulphuric acid, common salt, potassium chloride and magnesium sulphate), the maximum thickness which could be traversed by the waves employed, that is to say, the transparencies for the waves, varies in the same sense as the resistances, but not in proportion.—The vapour tension of solutions. The hypothesis of Arrhenius, by M. A. Ponsot.—An attempt at an immediate analysis of nervous tissue, by M. N. Alberto Barbieri.—On the cycloplasmic maturation, by M. Yves Delage.—Carboniferous goniatites in the Sahara, by M. Collot. The discovery of goniatites in the carboniferous layers of the Sahara points to an age a little more recent than that deduced by M. Ficheur, and it shows further that there were several levels, amongst which that which furnished the goniatites may be contemporaneous with the layers observed by Foureau in the Tassli Adzjer.—A physiological photometer, by M. G. M. Stanoiévitch.

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THURSDAY, AUGUST 22, 1901.

JAPANESE SPONGES.

Studies on the Hexactinellida. Contribution I. (Euplectellidæ). By Isao Iijima. Pp. 299; 14 plates. (Reprinted from the *Journal of the College of Science*, Imperial University, Tōkyō, Japan, vol. xv. 1901.)

THIS important memoir is the first instalment of a general monograph of the rich Hexactinellid fauna of the Japanese seas, upon the study of which the author has been engaged for the last seven years, with the result of increasing very largely the list of these interesting and beautiful sponges known to occur in that part of the world. Four species of *Euplectella*, three of *Regadrella* and one of *Walteria* are here described in great detail, and all but two of them are species described and named by the author himself, either in previous publications or in this memoir for the first time. The part of the work, however, which above all claims the attention of the zoologist who is not specially interested in this group of animals, or in the faunistic problems which attach to them, is the detailed account of the histology and organisation of *Euplectella marshalli* (pp. 116–200). The author has had at his disposal a very abundant material of this sponge, which he was able to preserve by various methods directly after capture. As the result of his careful studies upon this valuable material, the author describes in these Hexactinellids a type of structure which is radically different in two main points from that of all other sponges, and in both respects probably to be regarded as more primitive.

In the first place, he finds no trace of the intercellular matrix or mesoglœa of the connective tissue parenchyma, which in other sponges forms the chief mass of the sponge body. In the second place, perhaps in consequence of the absence of any such ground substance, there is no layer of flat epithelium to be found on any part of the sponge body, neither on the external surface nor in the canal system.

The dermal layer, in short, forms in these Hexactinellids a system of trabeculæ, composed of fused cells corresponding to the collencytes of other sponges, which here form a continuous protoplasmic syncytium with scattered nuclei. In this syncytium the spicules are laid down, but there is no secreted matrix apart from them and from the protoplasm of the syncytium, nor is there any flat epithelium covering the exposed surfaces. The trabeculæ anastomose and form a cobweb-like felt-work, through which the water filters both before and after traversing the flagellated chambers. At the external and internal surfaces of the body wall the trabeculæ are expanded to form film-like membranes perforated by numerous gaps or pores, the so-called dermal and gastral membranes. In the trabecular system are found other cellular elements, the archæocytes, with their modifications into nutritive and reproductive elements.

If the author's observations are confirmed, therefore, the Hexactinellids stand on a lower plane of evolution, at least as regards histological structure, than any other sponges, in that the dermal layer forms only one category of cell elements and is not differentiated into separate epithelial and connective tissue strata. This conclusion, it is hardly necessary to point out, is in direct antagonism to the view, still maintained by many authorities, according to which these two commonly found differentiations of the dermal layer are to be regarded as an "ectoderm" and a "mesoderm" respectively. In the author's words, the Hexactinellids "are a group of sponges which have undergone a far-reaching development and differentiation in the spicules, but have remained in a primitive condition so far as certain points in the soft parts are concerned."

The author has also made a number of important observations upon other points of microscopic structure. He brings forward the first observations yet made upon the formation of spicules in these sponges. He has also observed "archæocyte congeries" which he believes to give rise to free larvæ, thus reverting to, and supporting, the view of H. V. Wilson, that many sponge larvæ are really free-swimming gemmules, and are not egg-larvæ. But the account given of the collar cells and flagellated chambers merits special mention, as differing in some points, both important and unimportant, from Schulze's recently published description of the collar cells in another Hexactinellid, *Schaudinnia arctica.* Each collar cell has a flattened basal portion containing the nucleus and running out into ramifying processes, which anastomose with those of neighbouring cells to form the "reticular membrane" of Schulze. According to Iijima, all the meshes of the reticular membrane are open and serve as prosopyles or chamber pores, which are therefore practically equal in number to the collar cells themselves, "converting the epithelium into a veritable sieve membrane." The trabeculæ of the dermal layer attach themselves directly to the reticular membrane. The "polyprosopylar" condition here described contrasts sharply with what is seen in other sponges, and in the author's opinion it is correlated with the absence of mesoglœa. In sponges other than Hexactinellids, *i.e.* in Calcarea and Demospongiæ, the copious deposit of the ground substance round the bases of the collar cells necessarily blocks the free infiltration of the water between them, and causes a specialisation of the prosopyles; they become few in number and restricted in distribution, while between them the collar cells close up their ranks and extinguish the gaps in the wall. In Calcarea at least, it may be added, the prosopyles are further guarded, each by a special cell or porocyte of the dermal layer. These porocytes have not as yet, however, been demonstrated to occur in Demospongiæ, and their existence in Calcarea is, perhaps, a peculiarity of this group alone.

The histological facts brought forward by the author throw a flood of light upon the nature of the prosopyles or primitive pores of sponges, and if carried back in imagination to the primitive vase-like Olynthus form, which was probably the ancestor of all sponges, they permit of interesting speculations as to the probable structure of the body wall in such a form. The earliest type of sponge must be pictured as entirely without mesoglœa, and with a thin basket-like wall perforated by very numerous pores or interstices, corresponding to the intervals between the collar cells. The first advance towards strengthening this fragile structure would have been the secretion of spicules, formed by cells, probably at first very few in number, of the dermal layer, which continually increased in numbers and in importance, not only for the better support and protection of the sponge body and in particular of the reproductive cells, but also, perhaps, for entangling and capturing the nutritive particles brought by the water current. Clearly, so delicate an organism could only maintain its existence in tranquil water. The ancestors of the Calcarea and Demospongiæ, by the development of a thick and often very tough mesoglœa and a highly differentiated dermal layer, attained to the degree of firmness necessary for life in the littoral zone. The Hexactinellids, with a more primitive type of histological structure, have retained also their ancient deep-sea habitat.

Enough has been said to show the important results of Prof. Iijima's researches. We may add that the plates accompanying the work are a credit, not only to the author, but also to Japanese lithography. We shall await further instalments with much interest. E. A. MINCHIN.

INSTRUCTION IN VILLAGE SCHOOLS.

Rural Readers. Book I. By Vincent T. Murché. Pp. 168. (London: Macmillan and Co., Ltd., 1901.)

The Teacher's Manual of Object Lessons for Rural Schools. Books I. and II. By the same author. Pp. 231 and 252.

THESE books have been written by the headmaster of the Boundary Lane Board School, Camberwell, to meet the requirements of teachers in rural schools as laid down in the suggestive circular recently issued by the Board of Education. Mr. Murché claims to be an old hand at rural education, and the books before us certainly bear out his claim. If properly used, teachers will find them most valuable guides in introducing nature study into elementary schools. Their value is so much dependent on their mode of use that the author's caution, as given in the preface, must be kept well in mind. He says,

> "*These books are not intended to form a rigid cast-iron scheme of lessons*, to be blindly followed by every teacher into whose hands they may fall. They are rather to be considered as *a store-house from which the teacher may draw*, to suit his own special conditions; and further, the ample provision of subjects in each volume will enable him for years to construct scheme after scheme, all of them dealing with *just those subjects which will appeal to country children.*"

A brief summary of the contents will enable our readers to form an idea of the ground covered. Book I. (Object Lessons) contains forty lessons, grouped under six headings; lessons from simple natural phenomena such as the air, the sky, the sun, clouds and rain, wind and weather, &c.; round about the farm; lessons on the seasons; animals kept on the farm; and some useful minerals. Book II. contains forty lessons, grouped under lessons from animals, domestic and wild; lessons from birds; lessons from plants, and a number of miscellaneous lessons. The "Reader," of which the first part only is at present before us, is arranged in dialogue form and is to be used in conjunction with the corresponding volume of object lessons. We have nothing but praise for Mr. Murché's little books. They are the best of the kind that have hitherto come under our notice, and should go a long way towards facilitating that kind of teaching which all those who have taken part in the modern revival in rural education have been so anxious to see introduced into village schools. The great danger attending the use of such books is of course the tendency shown by teachers to make a fetish of the printed page. It is so much easier to teach didactically and to pump information into pupils from printed books than it is to develop their individual powers of observation and reasoning that extreme advocates of the "heuristic" method might take exception to the present volumes, as calculated to play too much into the hands of the teacher and to leave too little to the pupils themselves. But this danger is not confined particularly to rural education; it lurks in the pages of teachers' manuals in every branch of science, and if the publication of such works has injured the cause of true education it is more frequently the teachers than the authors who are at fault.

With respect to rural education in particular, it must not be forgotten that it has lagged far behind the education in towns, and that now—largely owing to the work of the Agricultural Education Committee—it is in a state of transition. The practical difficulties in the way of rational teaching in village schools are familiar to all who have attempted to grapple with the problem. Not the least of these difficulties is the imperfect education of the teachers themselves. Some of the technical instruction committees, as in Essex, have done good work through their normal classes, but much remains to be done before a body of teachers thoroughly trained in the requirements and in full sympathy with the objects of rural education can be called into existence. There are teachers in many such schools who are anxious to meet the new conditions now made possible through the enlightened policy of the Board of Education if they are helped in the way that Mr. Murché has attempted to help them by showing what there is to teach and how to teach it. If conducted rationally and scientifically, these object lessons will certainly accomplish the purpose for which they are written.

There is one little side issue to which the writer of this notice is glad of the present opportunity of calling attention. Now that the education of country children is making a serious departure in the right direction, the time seems ripe for inculcating that respect for living nature which is generally absent in the average child. Boys and girls are naturally destructive animals. The teachers in rural schools can do more than any other class of people to restrain and direct this tendency. They have to deal with children at the most impressionable period of their lives, and they have it in their power to point out exactly why wanton destruction is to be deprecated. The collecting of the common forms of animal and vegetable life for the purposes of study, *i.e.* for educational purposes, might be encouraged *judiciously*, but the ruthless destruction that accompanies the ordinary country ramble should be severely censured. If hordes of village school children are to be taken out into the country without proper restraint, the "nature study" is apt to degenerate into a mere collecting raid with no educational value and with serious consequences to our native fauna and flora. The teachers have it in their hands to impress upon their pupils that nothing is to be gained and everything to be lost by plucking every flower because it looks pretty, by raiding every nest because it is good sport, or by killing every insect that looks strange. If by proper tuition the child can be made to realise how infinitely more instructive and interesting is the living organism than the dead "specimen," a well-organised course of nature study should have as distinct a moral influence as it is intended to have an intellectual influence in moulding the character of the pupil. For this reason we should like to see in such works as those under consideration special and emphatic recommendations to teachers to repress all unscientific collecting. R. MELDOLA.

HEDDLE'S MINERALOGY.

The Mineralogy of Scotland. By the late M. Forster Heddle, M.D., F.R.S.E., Emeritus Professor of Chemistry, St. Andrews. Edited by J. G. Goodchild, H.M. Geological Survey, F.G.S. Two vols. Pp. 148 and 212. (Edinburgh: David Douglas, 1901.)

NO book is of more use to the practical mineralogist and collector than one which describes in a detailed manner the mineral localities of a country. Among the best examples are the lexicon of Zepharovich and Becke for Austria; that of Frenzel for Saxony; and, on a much more elaborate scale, the treatise by Lacroix on the mineralogy of France and her colonies, which is still in progress.

Greg and Lettsom's "Mineralogy of Great Britain and Ireland" (1858) is also a very useful book of reference, but scarcely adequate at the present date. Much of that work was actually due to Prof. Heddle; and it was known that he was for many years collecting materials for a "Mineralogy of Scotland"; no man possessed anything like his intimate knowledge of Scotch localities, so that a treatise of considerable importance and magnitude was expected from him.

After his death the unfinished manuscript was left to Mr. Alexander Thoms, who placed the work of completion in the competent hands of Mr. J. G. Goodchild. The present handsome volumes are the result, and it is evident that no trouble has been spared in their production. The book is a worthy monument of Prof. Heddle's lifelong labours, and will rank with the above-mentioned treatise of Lacroix.

Mr. Goodchild's task must have been a heavy one. There was a great mass of detail to be sifted; many of the localities have been difficult to identify, having been phonetically spelt by the author in his early journeys and not existing in the maps; further, it is not known to what specimens many of the figures relate, or what is the meaning of their symbols.

Prof. Heddle was an expert draughtsman, and there are no less than 103 plates, each containing about eight figures beautifully drawn and engraved. But many of these are taken from other sources, and their origin is doubtful. Confronted with the impossibility of making a trustworthy selection, the editor has thought it best to publish all the figures, though many of them have, perhaps, little direct bearing on the mineralogy of Scotland. These figures, and the numerous chemical analyses quoted throughout the book bear witness to Prof. Heddle's untiring industry.

In addition to these plates, a remarkable feature of the book is a number of beautiful and elaborate stereographic and gnomonic projections drawn by Mr. Wilbert Goodchild. The only book which has hitherto been provided with such complete stereographic projections is Des-Cloizeaux's "Manuel de Minéralogie," and even they are not so elaborate as those which adorn the present book. The gnomonic projections are quite a new feature, and will probably be found useful. The book is, further, provided with very complete tables and indices of mineral names, localities, pseudomorphs, &c.

A great part of such a book as this must necessarily consist of a mere list of localities; but, in addition, an account of the crystalline forms and of the physical and chemical properties is given for each mineral, and under some species will be found a good deal of interesting comment and historical information—conspicuous examples are gold, silver, galena and niccolite.

The reader's attention may be particularly directed to the description of agate and onyx, where he will find a very interesting and suggestive account of their probable mode of formation.

The most important part of the book is the description of the mineral localities; errors in the other portions are not of so much account, but it may be noted that it is not correct to call the form x of quartz a double three-sided pyramid, nor the face a the twin plane of pyrites.

The term gleit-face is a curiously hybrid expression for the glide-plane (*Gleitebene*) of calcite, and some of the terms used in the description of the varieties of agate, such as Jasp-agate, Oonachatæ, Hæmachatæ, Hæma-ovoid agate, can scarcely be regarded as satisfactory.

One failing inseparable from a posthumous work of this character may be noted; the reader, not knowing how much is generally established fact, and how much derived from incomplete or inadequate notes of the author, cannot feel equal confidence in all the statements. It is difficult, for example, to feel entire confidence in the occurrences of some obscure minerals, or in the identification of many of the crystal forms. It would have been well if Mr. Goodchild could have distinguished in some way those statements which he has been able to confirm from his personal knowledge and from his own extensive experience or from that of others. An appendix which contains some of his own observations is for this reason particularly valuable.

The book, as a whole, is remarkably free from the ornate style and the tinge of romance displayed by many of Prof. Heddle's published papers. It must long remain the standard treatise on the mineralogy of Scotland. It is satisfactory to know that the author's extensive collection of Scotch minerals is in the Museum of Science and Art at Edinburgh, and has been carefully arranged and made intelligible to the public by Mr. Goodchild, to whom the hearty thanks of all mineralogists are due for the labour and care which he has bestowed both upon the collection and upon the present treatise.

H. A. MIERS.

THE CIRCULATION OF THE ATMOSPHERE.

Mémoires originaux sur la Circulation générale de l'Atmosphere. Annotés et Commentés par Marcel Brillouin, Maître de Conférences à l'École Normale Supérieure. Pp. xx + 163. (Paris: Georges Carré et C. Naud, 1900.)

THIS may be described as a French Student's note-book of foreign memoirs upon the general circulation of the atmosphere. It contains papers upon the subject, partly translated in full, partly in extract or analysis, by Halley, Hadley, Maury, Ferrel, James Thomson, W. von Siemens, Möller, Oberbeck and von Helmholtz, with a short introduction and some critical notes to the current text.

The book may be welcomed as calling attention to a subject which greatly needs attention in this country. But little has been done for it since James Thomson, in the Bakerian lecture of 1892, revived the ideas he had originally put forward at the meeting of the British Association at Dublin in 1857. In the United States Prof. Cleveland Abbé has collected and translated the principal memoirs, but the mathematical treatment of atmospheric circulation has been neglected in England.

Contrary to the general experience of scientific books in French, the work is rather dull. The introduction makes it clear that only foreign memoirs are included, and the work of MM. Tastes and Duclaux, as well as that of M. Teisserenc de Bort and of M. Brillouin himself, particularly "Vents contigus et nuages" (*Ann. du Bur. Centr. Mét.* 1898) is only incidentally referred to, but this does not altogether account for the impression. The subject itself is difficult; indeed, in its details it is far beyond the power of mathematics. No one can suppose that it is possible to deduce the actual motion of the air at this instant at every part of the globe from its primary causes, namely the insolation of one half the globe, the radiation from the other half, the force of gravity and the rotation of the earth; and yet that is what, in a generalised manner, most of the authors quoted set out to do. Of course, a conventional atmosphere has to be used and a conventional circulation therein accounted for; and, as a matter of fact, the assumptions and conventions that a writer makes in order to bring his powers of calculation to bear are more interesting than the details of elaborate mathematics on artificial hypotheses leading to results which, to put the matter bluntly, are only true in so far as they are not new.

Von Siemens' application of the principles of conservation of momentum and of energy strikes a livelier key, but it is only when von Helmholtz's papers are reached that the reader can feel that the analysis has really become an engine of research. The mode of treatment becomes quite different. The hydrodynamics and thermodynamics of real air are the starting point, and equatorial heating becomes a secondary consideration. As each section is developed, and the dynamical effect of the scale of the problem, the equilibrium shapes of atmospheric layers, the wave phenomena that can occur between layers of different density are unfolded, it becomes possible to be enthusiastic as to the service that mathematics can render to this subject.

Von Helmholtz himself gives no general system of atmospheric circulation, but M. Brillouin indicates the results in that direction that flow from his conclusions. He finds them in general agreement with Ferrel's distribution, and pays a tribute to Ferrel's achievement on that account.

The notes throughout are frank, appropriate and useful. It is to be feared that the book appeals to a limited class of readers, namely those who are at the same time meteorologists and mathematicians. The ordinary meteorologist will feel the want of a mathematical introduction, and the ordinary mathematician of a meteorological introduction.

W. N. S.

OUR BOOK SHELF.

The Elements of the Differential and Integral Calculus. By J. W. A. Young, Assistant Professor of Mathematical Pedagogy in the University of Chicago, and C. E. Linebarger, Instructor in Chemistry and Physics in the Lake View High School, Chicago. Pp. xvii + 410. (London: Hirschfeld Bros., 1900.) Price 10*s*. 6*d*. net.

Differential and Integral Calculus with Applications for Colleges, Universities, and Technical Schools. By E. W. Nichols, Professor of Mathematics in the Virginia Military Institute. Pp. xi + 394. (Boston, U.S.A.: D. C. Heath and Co., 1900.)

THE first of these books is based upon the German treatise on the differential and integral calculus with special reference to chemistry which was published by Profs. Nernst and Schönflies five or six years ago. The chief alteration in the mode of presenting the subject is that the method of limits is used throughout in the treatise before us to the exclusion of the method of differentials which was early introduced and much employed in the German text-book. But the distinctive feature of the original work, viz. the continual use of illustrative examples from chemical and physical science, has been retained in the adaptation before us, and many additional examples of the like kind have been introduced.

The treatise in its present shape forms a very convenient and serviceable text-book for English and American students of chemistry desirous of obtaining an elementary acquaintance with the principles and methods of the calculus, for here they will find a very clear presentation of the fundamental ideas of the subject, and in particular will be furnished with abundant easy exercises and applications of the mathematical processes to subjects in which they are specially interested. The book is well designed to save the time and keep up the interest of such students. Thus the first chapter contains an introduction to analytic geometry, with numerous exercises on the graphing of curves, and the last chapter is a characteristic one on the differentiation and integration of functions found empirically.

Whilst so much has been done to smooth the path and provide for the wants of the class of students specially in view, it seems matter for regret that an additional chapter on the solution of easy linear differential equations has not been furnished.

We have in Prof. Nichols' work another elementary text-book specially designed as a first book on the calculus for students of physics and engineering. It is a clear and teachable work for beginners, and contains several easy applications to mechanics and electricity. The ordinary applications of the differential calculus to geometry are brought forward earlier than usual; thus we have a chapter on tangents, normals and asymptotes to plane curves before the chapters on successive differentiation, series, illusory forms and maxima and minima. Then, after a chapter on partial and total differentiation, we have applications to curvature, envelopes, singular points and tracing of curves.

The second part of the book contains the fundamental methods of the integral calculus, including a slight treatment of double and triple integrals and their applications to surfaces and volumes.

There is also a short chapter on differential equations, giving the methods of dealing with some of the simpler forms, and the concluding chapter contains applications to such subjects as moments of inertia and the deflection of beams.

Compared with recent English treatises on the calculus for engineering and physical students, the work before us appears slight and superficial in its technical applications. But as an elementary text-book on pure mathematics it has decided merit, and is evidently the production of an experienced teacher.

Album de Aves Amazonicas. Organisado pelo Dr. Emilio A. Goeldi, Director do Museu Paraense. (Museu Paraense de Historia Natural e Ethnographia, 1900.)

THE illustrated supplement to Dr. Goeldi's "Aves do Brazil," of which the first part, consisting of twelve coloured plates designed by Señor Ernesto Lohse, has been issued, will when completed give a good general idea of the avifauna of those regions. The birds represented in the present fasciculus comprise the cormorants, grebes, gulls, terns, waders, plovers, herons, egrets, boatbill, storks, spoonbills, rails, geese, ducks, toucans and kingfishers, as well as those two curious forms, the hoactzin and the sun-bittern. In herons and their allies the country is very rich, and two plates illustrate ten species of toucan, both sexes in this, as well as in other cases, being figured when desirable. Several species are figured on most of the plates, and they number eighty in all. But one plate is entirely devoted to a beautiful illustration (produced from an instantaneous photograph taken in 1900) of a breeding-place of the scarlet ibis. The crowd of graceful scarlet birds, backed by the rich, deep greenery of the western tropics, must afford a sight worth going to South America to see. There are pleasing bits of tropical scenery in the background of the plates, which form quite pretty pictures. The work has been printed at Zürich, and although the designs are on a rather small scale, and too much must not be expected of colour-printing, the illustrations of the birds strike us as being decidedly good, and we readily recognise at a glance several old South American acquaintances. The supplement will be most useful to any one travelling in the country who takes even a passing interest in natural history. The plates, like Dr. Goeldi's recently completed "Aves do Brazil," may be regarded as decidedly popular, and on that account will doubtless prove the more generally useful.

Qualitative Chemical Analysis, Organic and Inorganic. By F. Mollwo Perkin, Ph.D. Pp. viii + 266. (London: Longmans, Green and Co., 1901.)

THIS book begins with a general account of dry reactions and reactions in solution, attention being paid both to the manipulative and the theoretical aspects. Then follows the usual account of metals in groups with their tests, and afterwards come the acids. The remaining third of the book is devoted to what is called organic analysis, and here appears the most distinctive feature, namely, a list of tests for a great variety of organic substances—acids, alcohols, sugars, nitrogenous bases, glucosides and alkaloids. The intention of the author, as declared in the preface, has been "to write a book in which theory and practice are more or less dovetailed." It is difficult to find any realisation of this in the large section devoted to organic substances, but the treatment of the inorganic section is more in accordance with the stated object. A. S.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Fire Walk Ceremony in Tahiti.

THE very remarkable description of the "Fire Walk" collected by Mr. Andrew Lang and others had aroused a curiosity in me to witness the original ceremony, which I have lately been able to gratify in a visit to Tahiti.

Among these notable accounts is one by Colonel Gudgeon, British Resident at Raratonga, describing the experiment by a man from Raiatea, and also a like account of the Fiji fire ceremony from Dr. T. M. Hocken, whose article is also quoted in Mr. Lang's paper on the "Fire Walk," in the *Proceedings* of the Society for Psychical Research, February, 1900. This extraordinary rite is also described by Mr. Fraser in the "Golden Bough," and by others.

I had heard that it was performed in Tahiti in 1897, and several persons there assured me of their having seen it, and one of them of his having walked through the fire himself under the guidance of the priest, Papa-Ita, who is said to be one of the last remnants of a certain order of the priesthood of Raiatea, and who had also performed the rite at the island of Hawaii some time in the present year, of which circumstantial newspaper accounts were given, agreeing in all essential particulars with those in the accounts already cited. According to these, a pit was dug in which large stones were heated *red hot* by a fire which had been burning many hours. The upper stones were pushed away just before the ceremony, so as to leave the lower stones to tread upon, and over these, "glowing red hot" (according to the newspaper accounts), Papa-Ita had walked with naked feet, exciting such enthusiasm that he was treated with great consideration by the whites, and by the natives as a God. I found it commonly believed in Tahiti that anyone who chose to walk after him, European or native, could do so in safety, secure in the magic which he exercises, if his instructions were exactly followed. Here in Tahiti, where he had "walked" four years before, it was generally believed among the natives, and even among the Europeans present who had seen the ceremony, that if anyone turned around to look back he immediately was burned, and I was told that all those who followed him through the fire were expected not to turn until they had reached the other side in safety, when he again entered the fire and led them back by the path by which he had come. I was further told by several who had tried it that the heat was not felt upon the feet, and that when shoes were worn the soles were not burned (for those who followed the priest's directions), but it was added by all that much heat was felt about the head.

Such absolutely extraordinary accounts of the performance had been given to me by respectable eyewitnesses and sharers in the trial, confirming those given in Hawaii, and, in the main, the cases cited by Mr. Lang, that I could not doubt that if all these were verified by my own observation, it would mean nothing less to me than a departure from the customary order of Nature, and something very well worth seeing indeed.

I was glad, therefore, to meet personally the priest, Papa-Ita. He is the finest looking native that I have seen; tall, dignified in bearing, with unusually intelligent features. I learned from him that he would perform the ceremony on Wednesday, July 17, the day before the sailing of our ship. I was ready to provide the cost of the fire, if he could not obtain it otherwise, but this proved to be unnecessary.

Papa-Ita himself spoke no English, and I conversed with him briefly through an interpreter. He said that he walked over the hot stones without danger by virtue of spells which he was able to utter and by the aid of a goddess (or devil as my interpreter had it), who was formerly a native of the islands. The spells, he said, were something which he could teach another. I was told by others that there was a still older priest in the Island of Raiatea, whose disciple he was, although he had pupils of his own, and that he could "send his spirit" to Raiatea to secure the permission of his senior priest if necessary.

In answer to my inquiry as to what preparations he was going to make for the rite in the two or three days before it, he said he was going to pass them in prayer.

The place selected for the ceremony fortunately was not far from the ship. I went there at noon and found that a large shallow pit or trench had been dug, about nine feet by twenty-one feet and about two feet deep. Lying near by was a pile containing some cords of rough wood and a pile of rounded water-worn stones, weighing, I should think, from forty to eighty pounds apiece. They were, perhaps, 200 in number, and all of porous basalt, a feature the importance of which will be seen later. The wood was placed in the trench, the fire was lighted and the stones heaped on it, as I was told, directly after I left, or at about twelve o'clock.

At 4.0 p.m. I went over again and found the preparations very nearly complete. The fire had been burning for nearly four hours. The outer stones touched the ground only at the edges of the pile, where they did not burn my hand, but as they approached the centre the stones were heaped up into a mound three or four layers deep, at which point the lowest layers seen between the upper ones were visibly red-hot. That these latter were nevertheless sending out considerable heat there could be no question, though the topmost stones were certainly not red-hot, while those at the bottom were visibly so and were occasionally splitting with loud reports, while the flames from the burned wood near the centre of the pile passed up in visible lambent tongues, both circumstances contributing to the effect upon the excited bystanders.

The upper stones, I repeat, even where the topmost were presently removed, did not show any glow to the eye, but were unquestionably very hot and certainly looked unsafe for naked feet. Native feet, however, are not like European ones, and Mr. Richardson, the chief engineer of the ship, mentioned that he had himself seen elsewhere natives standing unconcerned with naked feet on the cover of pipes conveying steam at about 300° F. where no European foot could even lightly rest for a minute. The stones then were hot. The crucial question was, *how* hot was the upper part of this upper layer on which the feet were to rest an instant in passing? I could think of no ready thermometric method that could give an absolutely trustworthy answer, but I could possibly determine on the spot the thermal equivalent of one of the hottest stones trodden on. (It was subsequently shown that the stone might be much cooler at one part than another.) Most obviously, even this was not an easy thing to do in the circumstances, but I decided to try to get at least a trustworthy approximation. By the aid of Chief Engineer Richardson, who attended with a stoker and one of the quartermasters, kindly detailed at my request by the ship's master, Captain Lawless, I prepared for the rough but conclusive experiment presently described.

It was now nearly forty minutes after four, when six acolytes (natives), wearing crowns of flowers, wreathed with garlands and bearing poles nearly fifteen feet long, ostensibly to be used as levers in toppling over the upper stones, appeared. They were supposed to need such long poles because of the distance at which they must stand on account of the heat radiated from the pile, but I had walked close beside it a moment before and satisfied myself that I could have manipulated the stones with a lever of one-third the length, with some discomfort, but with entire safety. Some of the uppermost stones only were turned over, leaving a superior layer, the long poles being needlessly thrust down between the stones to the bottom, where two of them caught fire at their extremities, adding very much to the impression that the exposed layer of stones was red hot, when in fact they were not, at least to the eye. These long poles and the way they were handled were, then, a part of the ingenious "staging" of the whole spectacle.

Now the most impressive part of the ceremony began. Papa-Ita, tall, dignified, flower-crowned and dressed with garlands of flowers, appeared with naked feet and with a large bush of "Ti" leaves in his hands, and, after going partly around the fire each way uttering what seemed to be commands to it, went back and beating the stones nearest him three times with the "Ti" leaves, advanced steadily, but with obviously hurried step, directly over the central ridge of the pile. Two disciples, similarly dressed, followed him, but they had not the courage to do so directly along the heated centre. They followed about half-way between the centre and the edge, where the stones were manifestly cooler, since I had satisfied myself that they could be touched lightly with the hand. Papa-Ita then turned and led the way back, this time with deliberate confidence, followed on his return by several new disciples, most of them not keeping exactly in the steps of the leader, but obviously seeking cooler places. A third and fourth time Papa-Ita crossed with a larger following, after which many Europeans present walked over the stones without reference to the priest's instructions. The natives were mostly in their bare feet. One wore stockings. No European attempted to walk in bare feet except in one case, that of a boy, who, I was told, found the stones too hot and immediately stepped back.

The *mise en scène* was certainly noteworthy. The site, near the great ocean breaking on the barrier reefs, the excited crowd, talking about the "red-hot" stones, the actual sight of the hierophant and his acolytes making the passage along the ridge where the occasional tongues of flame were seen at the centre, with all the attendant circumstances, made up a scene in no way lacking in interest. Still, the essential question as to the actual heat of these stones had not yet been answered, and after the fourth passage I secured Papa-Ita's permission to remove, from the middle of the pile, one stone which from its size and position every foot had rested upon in crossing, and which was undoubtedly at least as hot as any one of those trodden on. It was pulled out by my assistants with difficulty, as it proved to be larger than I had expected, it being of ovoid shape with the lower end in the hottest part of the fire. I had brought over the largest wooden bucket which the ship had, and which was half-filled with water, expecting that this would cover the stone, but it proved to be hardly enough. The stone caused the water to rise nearly to the top of the bucket, and it was thrown into such violent ebullition that a great deal of it boiled over and escaped weighing. The stone was an exceedingly bad conductor of heat, for it continued to boil the water for about twelve minutes, when, the ebullition being nearly over, it was removed to the ship and the amount of evaporated water measured.

Meanwhile others, as I have said, began to walk over the stones without any reference to the ceremony prescribed by Papa-Ita, and three or four persons, whom I personally knew on board the ship, did so in shoes, the soles of which were not burned at all. One of the gentlemen, however, who crossed over with unburned shoes, showed me that the ends of his trousers had been burnt by the flames which leaped up between the stones, and which at all times added so much to the impressiveness of the spectacle, and there was no doubt that any one who stumbled or got a foot caught between the hot stones might have been badly burned. United States Deputy-Consul Ducorran, who was present, remarked to me that he knew that Papa-Ita had failed on a neighbouring island, with stones of a marble-like quality, and he offered to test the heat of these basaltic ones by seeing how long he could remain on the hottest part of the pile, and he stood there, in my sight, from eight to ten seconds before he felt the heat through the thin soles of his shoes beginning to be unpleasantly warm.

A gentleman present asked Papa-Ita why he did not give an exhibit that would be convincing by placing his foot, even for a few seconds, between two of the red-hot stones which could be seen glowing at the bottom of the pile, to which Papa-Ita replied with dignity, "My fathers did not tell me to do it that way." I asked him if he would hold one of the smaller, upper hot stones in his hand. He promised to do so, but he did *not* do it.

The outer barriers were now removed and a crowd of natives pressed in. I, who was taking these notes on the spot, left, after assuring myself that the stones around the edge of the pit were comparatively cold, although the centre was no doubt very hot, and those below red hot. The real question is, I repeat, how hot were those trodden on? and the answer to this I was to try to obtain after measuring the amount of water boiled away.

On returning to the ship this was estimated from the water which was left in the bucket (after allowing for that spilled over) at about ten pounds. The stone, which it will be remembered was one of the hottest, if not the hottest, in the pile, was found to weigh sixty-five pounds, and to have evaporated this quantity of water. It was, as I have said, a volcanic stone, and on minuter examination proved to be a vesicular basalt, the most distinctive feature of which was its porosity and non-conductibility, for it was subsequently found that it could have been heated red hot at one end, while remaining comparatively cool at the top. I brought a piece of it to Washington with me and there determined its specific gravity to be 0·39, its specific heat 0·19 and its conductivity to be so extremely small that one end of a small fragment could be held in the hand while the other was heated indefinitely in the flame of a blow-pipe, almost like a stick of sealing-wax. This partly defeated the aim of the experiment (to find the temperature of the upper part of the stone), since only the mean temperature was found. This *mean* temperature of the hottest stone of the upper layer, as deduced from the above data, was about 1200 degrees Fahrenheit, but the temperature of the surface must have been indefinitely lower. The temperature at which such a stone begins to show a dull red in daylight is, so far as I am aware, not exactly determined, but is approximately 1300 to 1400 degrees Fahrenheit.

To conclude, I could entertain no doubt that I had witnessed substantially the scenes described by the gentlemen cited, and I have reason to believe that I saw a very favourable specimen of a "Fire Walk."

It was a sight well worth seeing. It was a most clever and interesting piece of savage magic, but from the evidence I have just given I am obliged to say (almost regretfully) that it was not a miracle. S. P. LANGLEY.

Smithsonian Institution, Washington, D.C., August 7.

The Size of the Ice-grain in Glaciers.

IN referring to the size of the grain of the glacier in the chapter on chemistry and physics in the "Antarctic Manual," I have given 700 grammes as the maximum weight which I have observed. In August, 1895, I made an extended study of the structure of glacier ice, principally from the Aletsch Glacier. The fragments of this glacier, which float as icebergs in the Mergelin See, are exposed to the powerful weathering influence of the summer sun, and are comparatively easily dissected into their constituent grains. A number of blocks were so dissected in order to ascertain the weight and size of the largest grains. The following weights of single grains were determined:—700, 590, 450, 270, 255, 170, 155 and 100 grammes. It was observed that blocks of ice contained grains of all sizes, which fitted each other so exactly that, in the fresh unweathered block, the whole volume was filled with ice.

It was not then thought necessary to determine the weight of the smaller grains. On revisiting the Mergelin See in the latter part of July of this year, I dissected several blocks of ice more or less completely and weighed their constituent grains. In order to effect the dissection a powerful sun is requisite, and a powerful sun means a high atmospheric temperature, under the influence of which the small grains melt and disappear very quickly. All the grains in the block are melting at the same time, but the smaller the grain the greater is the ratio of its external surface to its mass. Therefore the weights of the large grains are reduced in a less degree than those of the small ones. Hence it is impossible to furnish an exact statistical account of any block of ice, but the figures in the following tables give a very fair idea of the structural composition of the ice examined. The analyses of blocks E and F are the most complete.

The first block, A, is from the lower end of the Glacier des Bossons in the Chamonix valley, and it was examined on July 17, 1901, which was one of the hottest days of that very hot week. The other blocks are all from the Aletsch Glacier, as they are found floating in the Mergelin See, the waters of which are retained at one end by the ice of that glacier. The Aletsch Glacier is the largest in Switzerland and it contains the largest ice-grains that I have met with. Different parts of the glacier, even in the immediate vicinity of the lake, are of different grain, and the fragments are easily distinguished as they float in the water. Thus block F is a block of large grained ice, while E is of comparatively small grained ice, though it is by no means of the smallest grain.

List of blocks dissected.

Block A.—Chamonix, July 17, 1901. From the end of the Glacier des Bossons.

Blocks B, C and D were taken from the Mergelin See on July 21, 1901, and exposed to the sun on a rock for some hours. B and C were then dissected, though not completely; that is, a certain comparatively small portion of each of them remained undissected. D was dissected only in so far as to enable a prominent and very large grain (570 grm.) to be removed and weighed. The remainder was left till the next day. Owing to the high temperature of the air both by night and by day, its size was very much reduced. It is called Block *d*, and it was dissected on July 22, 1901.

Block E from the Mergelin See was collected and dissected on July 22, 1901.

Block F had suffered far-reaching sun weathering. It was not removed from the lake, but was dissected in the water on July 24, 1901.

The results are embodied in the two following tables. All the

TABLE I.

Weight, in grammes of single ice-grains.			
A	C	*d*	F
160	230	125	
110	210	70	590
90	200	65	550
85	150	60	460
80	130	30	360
80	75	25	325
75	60	25	250
75	60		240
60	50		240
40	50	400	190
40	50		180
35	25		155
30	25	E	150
30	25	120	150
30	25	115	140
25		105	130
		85	130
	1365	70	125
1045		60	120
		60	120
		50	120
		50	110
		50	110
B		45	100
315		35	100
220		35	90
150		30	90
90		30	80
75	D	30	75
60	570	30	60
50	225	30	60
50	95	25	45
40	75	25	45
25	75	25	45
20	50	20	30
1095	1090	1125	5765

TABLE II.

Number of grains weighed.	Aggregate weight of grains.	Average weight of one grain.	Number of grains weighed.	Aggregate weight of grains.	Average weight of one grain.
	A			*d*	
16	1045	65·3	7	400	57·1
10	110	11·0	10	30	3·0
4	25	6·25			
10	25	2·5	17	430	25·3
40	1205	30·1		E	
			22	1125	51·1
			10	150	15·0
	B		10	135	13·5
11	1095	99·5	10	120	12·0
10	95	9·5	10	60	6·0
23	60	2·6	10	50	5·0
44	1250	28·5	10	40	4·0
			10	20	2·0
	C		10	15	1·5
15	1365	91·0	102	1715	16·8
5	50	10·0			
10	25	2·5		F	
			34	5765	169·6
30	1440	48·0	10	190	19·0
			10	190	19·0
	D		10	140	14·0
6	1090	182·0	6	60	10·0
5	30	6·0	40	70	1·75
11	1120	102·0	110	6415	58·3

weights are given in grammes. They were determined on a Salter's spring balance which carried 500 grammes, and its scale was divided into intervals of 10 grammes each. Ice-grains which weighed more than 500 grammes were divided in two.

As has been already pointed out, the figures in the tables do not give an exact statistical account of the blocks of ice. The smallest grains have most frequently escaped being weighed, therefore the average size of the grain comes out higher than the truth. The figures in the tables give a general idea of the constitution or anatomy of a block of ice taken from the lower part of a large glacier. They are particularly interesting when we reflect that every grain, even the largest, has grown, according to the rigid laws of crystallomorphic development, from a single snow crystal which probably weighed no more than one or two centigrammes.

In the Mergelin See, glacier ice can be studied in a way that is possible in no other place. The fragments of the Aletsch Glacier which float in it are veritable icebergs, and behave in the same way as their relatives in the Arctic or Antarctic Ocean. In the middle of summer, however, they are exposed to a much more powerful sun than either the northern or the southern bergs. Consequently, the weathering and disintegration, as well as the melting, proceed at a much more rapid rate.

The action of the sun's rays on glacier ice is twofold; it disarticulates the ice into its constituent grains, and it splits the individual grain up into laminæ perpendicular to the principal axis of the crystal and bounded by the planes of fusion discovered and described by Tyndall. These planes are the distinguishing characteristic of the individual ice-grain.

Under the influence of radiant heat an ice-crystal begins to melt at the surfaces which separate these laminæ, and the process of disintegration and decay is directed by their plane. On the other hand, an ice-crystal, floating in water and losing heat, generates ice laminæ which are directed by the same planes, which form the continuation of the corresponding laminæ of the parent crystal. This was well observed at the end of August, 1895. Every night a thin skin of ice was formed at the shallow end of the lake, where the ice blocks are collected. As the grains in a block of glacier ice are distributed quite irregularly, the water line of a floating block necessarily cuts a great number of grains, all of which are oriented differently. The ice which was formed during the night along this line was oriented crystallographically by the grain with which it was in contact and from which it appeared to spring in continuation of its crystalline laminæ. This produces a remarkable pattern of lines on the surface of the lake ice contiguous to a block of glacier ice.

Tyndall has described and figured the minute features of the disintegration of the crystal under the absorption of radiant heat. Similar and complementary features are observed when ice is generated from an existing crystal under the dissipation of heat. To do justice to them, however, would require the services of a skilful, patient and resourceful artist.

The disarticulating and analysing action of the sun's rays is not accomplished without the selection and expenditure of energy. Accordingly we observe that one grain protects another. The disarticulation into separate grains, although very thorough near the surface of a glacier, does not penetrate far. A stroke or two with an ice axe reveals the fresh blue ice. The analysis of the individual grain into crystallographically oriented laminæ can be particularly well studied in the Mergelin See. It is only the grains that are exposed to the sky, and above water, that are so analysed; and prolonged exposure of this kind reduces a grain to the last stage of dilapidation. The grains beneath the surface, *whether of ice or water*, are almost completely unattacked.

The importance, or rather the necessity, of direct sky-light for the disarticulation of glacier ice into its constituent grains is very well seen in the artificial grottoes which are maintained at easily accessible parts of most popular glaciers. The thickness of the layer of completely disarticulated ice is so small that it is hardly noticed, and the whole grotto appears to be cut out of pure blue ice. If the observer, on penetrating for a few paces, turns round and looks outwards, he sees the surface of the ice-walls of the grotto etched with strange line-figures. These are most strongly marked near the opening, and they cease exactly at the spot where the last ray of direct sky-light strikes the ice. The lines so developed are formed by the intersection of the surface of the ice-wall of the cave with the separating surfaces of contiguous ice-grains. The photographic picture thus presented is one of very great interest.

It is only perfectly pure water, received directly as it flows from the still, that can be frozen into homogeneous glass-like ice. All natural ice proceeds from impure water.

In lake ice of moderate thickness the crystalline axis is perpendicular to the surface of the lake. Consequently, Tyndall's planes of fusion are parallel to this surface. When exposed to a powerful sun, and with an air temperature even much below 0° C., the ice weathers into horizontal laminæ separated by Tyndall's planes of fusion, and into vertical columns. The column in lake ice and the grain in glacier ice are homologous features. They express the form which the individual crystal takes in these different varieties of natural ice.

Were it not for the fact that a glacier is made up of distinct grains of ice, and that this substance has the property of melting and freezing at different temperatures, according to the composition of the water with which it comes in contact and to the pressure to which it is subjected, there is little doubt that a glacier would be as motionless as any other mass of crystalline rock. J. Y. BUCHANAN.

August 6.

Problems of Geometry.

IN Klein's "Famous Problems of Elementary Geometry," geometrical proofs are given for solving the problems of "the duplication of the cube" and "the trisection of an angle" by means of the *cissoid* and the *conchoid* respectively. I find, however, that in "Chambers' Encyclopædia" it is stated, without proof, that the *cissoid* and the *conchoid* are capable of furnishing geometrical constructions for the solution of *both* problems. Can any of your readers furnish me with the necessary references, or supply a proof of the "trisection of an angle" by means of the *cissoid*, and of the "duplication of the cube" by means of the *conchoid*? A. B. BASSET.

Fledborough Hall, Holyport, Berks, August 9.

Forecast and Fact.

IN NATURE of January 12, 1893 (p. 246), I represented as probable an early descent of the smoothed curve of rain days at Greenwich, there given, "and a commencing series of (on the average) drier summers than we have had lately."

The following table may now be compared with this:—

	Rf. Summer.	Relation to av. (6·81)
1893	5·40	−1·41
1894	8·33	+1·52
1895	5·74	−1·07
1896	5·07	−1·74
1897	5·52	−1·29
1898	3·95	−2·86
1899	2·85	−3·96
1900	6·26	−0·55

Per contra, there is the chastening reflection that a rule which held good (with one exception) since 1815 (see *Symons' Met. Mag.*, June 1898, p. 70), and which was quoted in your columns, has broken down on this occasion, viz. that in the group of five summers ending with a sunspot minimum, there are more wet summers than dry! A. B. M.

Boomerangs.

IN relation to the interesting article on boomerangs in your issue of August 1, it may perhaps be of interest to some of your readers to know that Schiaparelli, in his famous book, "Entwurf einer astronomischen Theorie der Sternschnuppen," p. 13, speaks of "bumerangs." He says:—"Very likely the *cateja* described by Isidor of Seviglia was nothing but a sort of bumerang." "Est genus Gallici teli, ex materia quam maxime lenta, quæ jacta quidem non longe propter gravitatem evolat, sed quo pervenit, vi nimia perfringit: quod si ab artifice mittatur, rursus redit ad eum qui misit." Isidori Hispalensis, Origg, xviii. OTTAVIO ZANOTTI BIANCO.

Torino (Italy) Via della Rocca 28.

BATRACHIANS AND REPTILES IN THE CAMBRIDGE NATURAL HISTORY.[1]

IN the preface to this welcome volume the author reminds his readers of the words of Linnæus, "Amphibiologi omnium paucissimi sunt nullique veri." What progress has been accomplished by the "Amphibiologi"—herpetologists we now term them—in dealing with the "pessima tetraque animalia" during the 150 years which have elapsed since this statement of the great naturalist cannot be better realised than by a perusal of the excellent contribution supplied by Dr. Gadow for the eighth volume of the "Cambridge Natural History."

This work is not only of the highest interest in bringing together in a small compass and in a charming style the essence of a most voluminous literature; it derives special value from the authority of its writer as an anatomist and observer of the Batrachians and Reptiles both in their native haunts and in the vivarium.

Not content with giving us the benefit of his wide experience in the departments to which he has devoted so much study, Dr. Gadow has also suggested various reforms in the general classification, thus raising the work far above the usual standard of this kind of semi-popular treatises.

The following table will show the classification adopted, and which, on the whole, reflects so well the state of our present knowledge. The author explains in the preface that the principal groups are called subclasses in order to emphasise their taxonomic importance in comparison with the main groups of birds and mammals:—

	Subclass	Order	Suborder
Amphibia	Stegocephali	Lepospondyli	Branchiosauri, Aistopodes
		Temnospondyli	
		Stereospondyli	
	Lissamphibia	Apoda	
		Urodela	
		Anura	Aglossa, Phaneroglossa
Reptilia	Proreptilia		
	Prosauria	Microsauri	
		Prosauri	Protorosauri, Rhynchocephali
	Theromorpha	Pareiasauri	
		Theriodontia	
		Anomodontia	
		Placodontia	
	Chelonia	Atheca	
		Thecophora	Cryptodira, Pleurodira, Trionychoidea
	Dinosauria	Sauropoda	
		Theropoda	
		Orthopoda	Stegosauri, Ornithopodi
		Ceratopsia	
	Crocodilia	Pseudosuchia	
		Parasuchia	
		Eusuchia	
	Plesiosauria	Nothosauri	
		Plesiosauri	
	Ichthyosauria	Ichthyosauri	
	Pterosauria	Pterosauri	Pterodactyli, Pteranodontes
	Pythonomorpha	Dolichosauri	
		Mosasauri	
	Sauria	Lacertilia	Geckones, Lacertæ, Chamæleontes
		Ophidia	

The boldest attempt at innovation in taxonomy consists in the removal from the class Batrachia or Amphibia, as generally understood, to that of Reptilia, not only of the Microsauria, but of a number of other members of Cope's Stegocephalia. But this change is not one that is likely to commend itself. We all know how, in the light of recent palæontological discovery, most of the supposed distinctive features of the two classes in question have faded away, as instanced by Prof. Seeley's proposal to unite the Stegocephalia with the Reptiles, and Prof. Credner's establishment of the group Eotetrapoda for the reception of the earlier Batrachians and Reptiles. However, one thing appears certain to me: the Stegocephalia, as defined by Cope, form one compact group, distinguished from both Batrachians proper and Reptiles by the presence of additional dermal bones in the skull—the occipital (dermo-occipital) and the so-called "epiotic," which I regard as the homologue of the post-temporal of Fishes—and, further, in all cases where the pectoral arch is known, by their conforming to the type of the Crossopterygian and early Ganoid Fishes in the possession of the element termed cleithrum by Gegenbaur (clavicle of ordinary Teleosts) in addition to the clavicle proper. These highly important features, connecting the Crossopterygians with the Stegocephalians, are relegated to the background by Dr. Gadow, who prefers to establish the turning-point where to part the Reptilian phylum from the Batrachian upon the constitution of the elements of the vertebral column, Batrachians being defined as *acentrous*, *pseudocentrous* or *notocentrous*, that is to say, in which the author's "dorsal arcualia" are reduced or absent, Reptiles as *gastrocentrous*, the centra of the vertebræ being formed by pairs of "interventralia," while the "basiventralia" (intercentra of Cope) are reduced, persisting either as wedgebones or as intervertebral pads, or absent. This is the application of the views set forth by the author in his well-known paper published in the *Philosophical Transactions* for 1896; but it must be admitted that, so far as the Stegocephalia are concerned, the ideal distinction between interdorsalia and interventralia cannot be practically applied, owing to the types which connect *Eryops*, now proposed to be placed with the Reptiles together with the Embolomeri and Microsauria, and *Archegosaurus*, associated with the Labyrinthodonts. Whatever measure of truth Dr. Gadow's theory of the evolution of the vertebral column may contain, it is very doubtful whether any students of the fossil remains will be able to agree with him in regarding the composition of the tripartite vertebræ of these genera as due to "superficial resemblance." "After all," the author adds (p. 285), "we feel certain that Reptiles have arisen from Stegocephalous Amphibia, and it is in the Lower Permian, exactly where the debatable creatures lived side by side with the Stegocephali, undoubtedly likewise temnospondylous, that the change from Amphibia into Reptiles seems to have taken place."

It is highly probable that the Stegocephalians will be found to have been derived from the Crossopterygians and to lead, on the one hand, to the Batrachians through the Branchiosauria, and, on the other hand, to the Reptiles through the Microsauria. Perhaps the best means of getting over the difficulty with which we are confronted would be to raise the Stegocephalians to the rank of a class, which is quite capable of exact definition. But there is certainly no sufficient justification at present for the proposal to unite *Eryops* and the *Embolomeri* (*Proreptilia* of Gadow) with the Reptiles rather than with the Batrachians.

I would add that if Dr. Gadow thus repudiates the classification of Cope, it is contrary to the rules of nomenclature to make use in the sense he does of the name *Stegocephali*.

On the other hand, I hail with satisfaction the

[1] Amphibia and Reptiles. By Hans Gadow. "The Cambridge Natural History." Vol. viii. Pp. xiii + 668; 181 woodcuts. (London: Macmillan and Co., Ltd.) Price 17s. net.

systematic position given to the Apoda or Cæcilians (which name should not have been spelt Cœcilians).

In the division of the Anura or Ecaudata an attempt is made at reducing the number of families, but it is difficult to see what is to be gained by this reduction in a manner for which the author himself pleads guilty of inconsistency; a reproach which would apply likewise to some changes in the classification of the Lacertilia.

FIG. 1.—Australian tree-frog (*Hyla caerulea*).

In accordance with what I believe to be the duty of a reviewer, however more disposed he may feel to praise than to criticise, a certain prominence should be given to the pointing out of small errors, such as necessarily creep in all books of some extent, in order to prevent their propagation, especially in the case of a work which is certain to enjoy a wide circulation. I have, therefore, here noted a few which I have come across.

P. 11. The number of caudal vertebræ varies much in our species of newts. It might mislead the student in search of additional characters by which to distinguish *Triton palmatus* from *T. taeniatus* to read that the latter has about a dozen vertebræ more than the former.

P. 30. *Pelobates* cannot be described as a "very aquatic" genus. On the same page, *Amphodus* should have been mentioned as the best example of a frog with toothed parasphenoid.

P. 45. There is no difference in the nature of the external gills of *Protopterus* and *Lepidosiren*.

P. 95. On the map showing the distribution of the Urodela, the range of these Batrachians should be extended to Ireland, Southern Norway, Syria, Northern Persia and Peru. The habitat of *Plethodon platensis*, mentioned on p. 94, is not marked on the map.

P. 153. The tympanum is often very distinct in *Discoglossus*.

P. 161. The map does not show the eastern extension in Europe and to South-western Asia of the *Pelobatidae*, nor is it correct as to the distribution of the *Pelobatidae* and *Discoglossidae* in Eastern Asia and North America (cf. pp. 153, 162, 164, 165).

P. 167. The common toad occurs in Norway as far as 65° lat., as correctly stated on p. 177; but this is not shown on the map.

P. 189. The pupil is horizontal in *Diaglena* (as the name implies) and *Pternohyla*.

P. 198. The curious *Hyla goeldii* is from the Serra dos Orgãos, not from Pará.

P. 288. "Deeply amphicœlous vertebræ" is not true of all "Prosauria" (cf. *Hyperodapedon* and *Sauranodon*, the latter with procœlous vertebræ).

P. 332 (map). Testudinidæ, Cinosternidæ and Chelydridæ occur in Ecuador.

P. 499. The shell of the egg of *Lacerta viridis* and *L. agilis* is not hard like Geckos', but parchment-like, as described on p. 555, whilst that of *L. vivipara* is a mere membrane.

P. 500. The Scincidæ are represented by several species in New Zealand.

P. 501. Chameleons exist on the Seychelles (*Chamaeleon sechellensis*) and Mauritius.

P. 514. The Pygopodidæ cannot be described as leading a usually subterranean life, any more than our common slow-worm.

P. 529. The map showing the distribution of Anguidæ and Iguanidæ is not quite correct, since the former are represented in South-eastern China (*Ophisaurus harti*) and the latter extend to the South-eastern United States (*Anolis*, *Sceloporus*, *Phrynosoma*), as stated in the text.

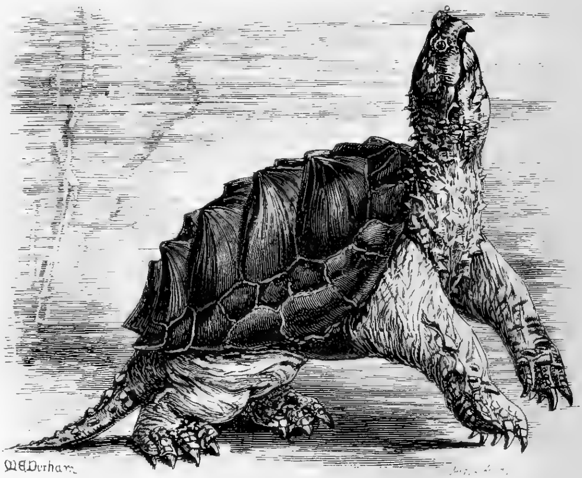

FIG. 2.—"Alligator turtle" (*Macroclemmys temmincki*).

P. 558. The Faraglione Rock near Capri is not blackish.

P. 565. The Amphisbænidæ are represented on the map as occurring all over Africa; but none are known from north of 12° lat. N. except the Mediterranean forms confined to the Atlas and the territory between it and the sea.

P. 644. The range of the *Crotalinae* extends to Celebes (*Lachesis wagleri*).

In matters of nomenclature, some inconsistency is displayed in the termination of the names of orders and suborders, and the use of the term "Sauria" for a group embracing lizards and snakes is unjustifiable.

The illustrations are for the greater part original, and many are actually taken from living specimens. So great a training is required to depict properly the attitudes of any class of animals, and especially the often mysterious-looking creatures which form the subject of the book under review, that only artists who have made a speciality of it can be expected to furnish nearly faultless work, which even then may be spoilt to a certain extent, so far as technical details are concerned, through the intervention of the engraver if, as in the present case, his services have also to be enlisted. It will, therefore, not be unnatural if an expert may find fault with a few of the illustrations in this book. For instance, Fig. 23 represents a difference between the heads of the male and female crested newt which does not really exist; Fig. 31 shows *Bombinator igneus* with the eyes much too far apart, Fig. 91 a *Trionyx* with azygous frontal bone, and Fig. 103 a ventral view of the hand of *Ptychozoon* with the inner finger longer than the outer, which is just the reverse of nature. But all the figures are marked by a freshness which makes up for any shortcomings, and many may be pronounced as exceptionally good.

In concluding the review I would express the opinion that by this handsome volume a very important addition to science has been made; that the beautiful illustrations, together with the clear and charming accounts of the life-histories which it contains, will do much to popularise the study of a rather neglected section of zoology; and that lovers of Reptiles, of which there are more than one generally thinks, will feel that the new knowledge imparted to them emanates from one who is thoroughly in sympathy with their enthusiasm. G. A. BOULENGER.

THE FORTHCOMING MEETING OF THE BRITISH ASSOCIATION.

IN the two articles which have already appeared (May 23 and July 18) upon the meeting of the British Association, to be held at Glasgow on September 11–18, the general arrangements made for the scientific and social pleasures of the members have been described. It is now possible to give an epitome of the programme of the meeting and a forecast of the work of the sections. The sections do not meet on September 11 and September 19, but on all intervening days.

Epitome of Programme.

Wednesday, September 11.—President's address in St. Andrew's Hall.

Thursday, September 12.—Conference of delegates of corresponding societies; inauguration of new anatomical buildings at the University, and the opening of the museum in connection therewith; reception and conversazione in the City Chambers, by invitation of the Lord Provost and Corporation of Glasgow.

Friday, September 13.—Garden party at Overtoun, Dumbartonshire, by invitation of the Lord and Lady Overtoun; lecture in St. Andrew's Hall, by Prof. W. Ramsay, F.R.S., subject: inert constituents of the atmosphere; smoking concert in Berkeley Hall of St. Andrew's Halls.

Saturday, September 14.—Excursions; lecture to artisans in St. Andrew's Halls, by Mr. H. J. Mackinder, subject: the movements of men by land and sea.

Sunday, September 15.—Official sermon in the Cathedral, by the Rev. Pearson M'Adam Muir.

Monday, September 16.—Garden party in the Botanic Gardens and Queen Margaret College, Glasgow, by invitation of the Lord Blythswood, president of the Glasgow Philosophical Society, and Lady Blythswood; lecture in St. Andrew's Hall, by Mr. Francis Darwin, F.R.S., subject: movements of plants.

Tuesday, September 17.—Special visits to public works; conference of delegates of corresponding societies; conversazione in the Exhibition Buildings, by invitation of the president, the chairman and the executive council of the Glasgow International Exhibition Association, 1901.

Wednesday, September 18.—Concluding general meeting; excursion to Paisley and luncheon in the Town Hall, by invitation of Sir Thomas Glen Coats, Bart.; reception and conversazione in the galleries of the Royal Scottish Society of Painters in Water Colours, 153, Sauchiehall Street, by invitation of the president (Sir Francis Powell, P.R.W.S.) and the council; "at home" in the Art Club, by invitation of the president (Mr. J. E. Christie) and the committee of the Glasgow Art Club; reception and conversazione in the Glasgow School of Art, by invitation of the chairman (Mr. James Fleming) and the governors; reception and conversazione in the galleries of the Royal Glasgow Institute of the Fine Arts, by invitation of the president (Sir John Stirling-Maxwell, Bart., M.P.) and the council of the Institute; annual inspection and dinner of the Clyde Navigation Trustees, to which a selected number (probably thirty) of members of the British Association will be invited; dinner by the Faculty of Physicians and Surgeons to a selected number of the medical members of the British Association.

By kind permission of the owners, a large number of shipbuilding yards, public works, &c., in Glasgow and district will be available to the inspection of members during the meeting. Details as to days and times are given in a special handbook and guide that is being prepared by the local committee.

In addition to the information given in NATURE of July 18 with regard to the sectional meetings, the following provisional programmes of sections have been received.

The president's address to Section B (Chemistry) will be on the position of British chemistry at the dawn of the twentieth century. In this address Prof. Percy Frankland, F.R.S., will direct attention to the factors which have been instrumental in promoting the growing activity in original investigation during the past twenty years. He will also point out the disadvantages at the present time incidental to university education, and will indicate some of the more important reforms which are required in the immediate future. Other papers which have been arranged for this Section are, bridged rings, by Prof. Perkin; the present position of electrochemical industries in this country and abroad, by Dr. Shields; the chemical exhibits at the Glasgow Exhibition, by Dr. Lewkowitsch; and ocean salt deposits, by Dr. E. F. Armstrong. The last paper may possibly be read at a joint meeting of Sections B and C. Prof. Letts will read papers on the chemical changes which occur during the contact of sewage with "bacteria beds," and on the assimilation of ammonia by the seaweed *Ulva latissima*.

In addition to Mr. J. Horne's presidential address, on recent advances in Scottish geology, to Section C (Geology), the following papers, among others, will be read:—On the volcanic episodes in the geological history of Arran, by Mr. William Gunn; (1) relation of the Old Red Sandstone of north-west Ireland to the Metamorphic rocks, (2) relation of the Silurian and Ordovician rocks of north-west Ireland to the Metamorphic series, by Messrs. A. McHenry and J. R. Kilroe; on a new method in the investigation of fossil remains, Prof. J. W. Sollas; (1) phosphatic nodules, &c., in Upper Carboniferous Limestone of west Yorkshire, (2) a silicified plant seam beneath the Millstone Grit of Swarth Fell, by Mr. John Rhodes; plants and Coleoptera of Pleistocene age from Wolvercote, Oxfordshire, by Mr. A. M. Bell; origin of gravel-flats of Surrey and Berkshire, by Mr. H. W. Monckton; (1) the distribution of fishes in the Carboniferous rocks of Scotland, (2) the fish fauna of the Old Red Sandstone of Scotland, by Dr. Traquair, F.R.S.; the Cambrian fossils of the north-west Highlands, by Mr. B. N. Peach, F.R.S.; fossil plants from Berwickshire, by Mr. R. Kidston; sequence of Tertiary igneous rocks of Skye, by Mr. A. Harker; the Scottish ores of copper and their geological relations, by Mr. J. G. Goodchild; recent observations among the volcanic rocks of Mull, by Sir Archibald Geikie; on Eastern Highland schists, by Mr. G. Barrow; on rock specimens from Perim, by Miss C. A. Raisin.

The address of the president of Section D (Zoology) (Prof. J. Cossar Ewart, F.R.S.), on the experimental study of variation, will be given on Thursday, September 12. The preliminary list of papers to be read shows that from a zoological point of view the Glasgow meeting will be one of exceptional interest; while the proximity of the Firth of Clyde and the establishment of the marine biological station at Millport will provide attractions of a special character for the marine biologist. The committee have invited lectures from Major Ronald Ross, F.R.S., on tropical parasitology, giving the results of his most recent investigations; and from Dr. J. E. S. Moore, on the problem of Lake Tanganyika. Both gentlemen have consented, subject, in the former case, to Major Ross's expected return from Africa in time. In addition to the above, Prof. J. Arthur Thomson will read a paper on germinal selection in its relation to inheritance; Mr. E. J. Bles, on a method of recording local fauna; Mr. L. A. Borradaile, on the land crabs of Minikoi; Mr. J. S. Budgett, on the youngest known larva of *Polypterus*; Mr. J. Graham Kerr, on the origin of vertebrate limbs; Mr. J. Y. Simpson, on variation in relation to binary fission in Protozoa; and Dr. T. H. Bryce, on heterotypical division in the maturation of sexual cells. These titles indicate the main outlines of the zoological programme, but the committee have not yet finally closed their list. A joint discussion with Sections C and E on limnology is provisionally arranged for Monday, September 16.

In Section E (Geography) the president's address will be delivered on Thursday, September 12, at 10.30 a.m., and will deal specially with the study of geography, as distinct from the teaching of that subject, in this country. Amongst the papers which it is hoped will be communicated to the Section during the meeting are:—Mr. G. G. Chisholm, geographical conditions affecting British trade; Mr. E. G. Ravenstein, Martin Behaim and his globe of 1492; Dr. A. J. Herbertson, a morphological map of Europe; Dr. R. Bell (Geological Survey of Canada), Northern Ontario; Dr. Moreno, on the Argentine Republic; Mr. W. N. Shaw, on weather maps; Mr. H. N. Dickson, on mean temperature and glacial periods; Dr. R. Logan Jack, on travels in Western China; Mr. Yule Oldham, on the Bedford level experiments. Captain Lemaire will give an account of his recent expedition. Special attention will be directed to the geography of Scotland, and it is hoped that Sir A. Geikie will read a paper on some questions relating to this subject; Mr. G. F. Scott Elliott has promised a paper on the effects of vegetation in the valley and plains of the Clyde; Dr. Marion Newbigin, on the proposed survey of the Forth valley, undertaken by the Scottish Natural History Society; and Mr. W. G. Smith, on the methods of the Botanical Survey of Scotland inaugurated by his brother, the late Mr. R. A. Smith. Papers will probably be read on the British and German Antarctic expeditions, and Mr. W. S. Bruce has promised a paper on the methods and plans of the Scottish Antarctic Expedition. It is hoped that a joint discussion may be arranged with other sections on the objects and methods of limnology. Sir Thomas Holdich will present the report of the committee on surveys of British Protectorates, and the reports of committees on the climate of Tropical Africa and on surveys of the Phlegræan Fields will also be read.

In Section G (Engineering), the provisional programme includes the following papers:—Address of the president, Colonel R. E. Crompton, on (*a*) modern development of passenger and goods traffic, as affecting carriage on railways, tramways and ordinary roads; (*b*) standardisation and interchangeability; (*c*) the National Physical Laboratory. Paper by Mr. D. H. Morton on the mechanical exhibits in the Glasgow Exhibition; report of the committee on resistance of road vehicles to traction; the carriage of goods over electric trolley systems, Mr. A. H. Gibbings; railway rolling stock, present and future, Mr. M. N. Macdonald; the Panama Canal, M. Bunau Varilla; tunnelling through quicksands, M. A. Gobert; the protection of public buildings from lightning, Mr. Killingworth Hedges; the Diesel engine, Herr Rudolf Diesel; aluminium, Prof. E. Wilson; aluminium as a fuel, Sir W. C. Roberts-Austen, K.C.B., F.R.S.; report of the committee on the small screw gauge; recent developments of chain driving, Mr. C. R. Garrard; the critical point in rolled steel joists, Mr. E. T. Edwards; machinery for engraving, Mr. Mark Barr; measurement of the hardness of materials by indentation by a steel sphere, Mr. T. A. Hearson.

Prof. D. J. Cunnningham, F.R.S., the president of Section H (Anthropology), will take as the subject of his address the human brain, and the part which it has played in the evolution of man; and papers on physical anthropology are likely to be more prominent this year than on some previous occasions. Special attention will be directed to recent work by Dr. Brown and Mr. Gray on the physical characteristics of the people of Ireland and Scotland respectively; Mr. Douglas, Superintendent of Police at Glasgow, promises an account of the anthropometric method of identification as practised locally; and other papers on Egyptian and Papuan anthropology are expected from Drs. Rivers and Myers. Two papers have been received on the natives of the Malay Peninsula, by Mr. Skeat, and Messrs. Annandale and Robinson. Dr. Sturge has a paper on the chronology of the Stone Age of man, and Mr. Arthur Evans will supplement the report of the Cretan Exploration Committee by an account of the Neolithic settlement which underlies the great Mycenæan palace of Knossos. Mr. Hogarth also promises an account of this year's campaign in eastern Crete. The report of the Canadian Ethnographic Survey promises, as before, a variety of subjects for discussion; and it is hoped that special arrangements may be made for the description and examination of the ethnographic and archæological sections of the Glasgow Exhibition; though at present the culture and archæology of the neighbourhood remain quite unrepresented in the programme.

The president of Section I. (Prof. J. G. McKendrick, F.R.S.) will open the work of the section with an introductory address. The feature of the transactions will, however, be a discussion on the subject of phonetics. This is to be introduced by a demonstration from the president of the different methods employed in researches into this subject, after which it is expected that Dr.

Lloyd (Liverpool), Dr. Pipping (Helsingfors), Dr. Boeke (Alkmaar) and others will take part in the discussion.

Communications are also promised from Dr. A. A. Gray (Glasgow), on the cochlea; from Dr. Kennedy (Glasgow), on the repair of nerves; from Dr. Edridge Green, on the classification of the colour blind; from Dr. R. Hutchison, on the chemistry of bone marrow. Other contributions are also promised from workers who have not as yet sent in titles. It is not anticipated, however, that the amount of work will be as great as usual, owing to the fact that many British physiologists are attending the International Congress to be held in Turin a week later than the Glasgow meeting.

A discussion on the teaching of botany will be opened in Section K by Mr. Wager and Prof. Bower from the point of view of school and university teaching respectively. Prof. Miall, Prof. Marshall Ward, Dr. Scott, Prof. Scott-Elliott and others are expected to take part in the discussion. On Friday afternoon, September 13, Prof. Reynolds Green will deliver a semi-popular lecture on flesh-eating plants. The following papers have been promised:—Prof. Bayley Balfour (president), morphological notes; Prof. Marshall Ward, the Bromes and their brown rusts; Mr. Wager, on the cytology of the Cyanophyceæ; Prof. Bower, on an *Ophioglossum* collected by Mr. Ridley; Dr. Lang, on the prothalli of *Helminthostachys*, *Ophioglossum pendulum* and *Psilotum*; on certain large prothalli of *Lycopodium cernuum*; on the mode of occurrence of the prothalli of *L. Selago* at Clova. Mr. Yapp, on two Malayan 'myrmecophilous' ferns; Miss Ford, on the anatomy of *Ceratopteris*; Mr. Brebner, on the anatomy of *Danaea* and other Marattiaceæ; Mr. Seward and Miss Ford, on the structure of *Todea*, and on the geological history of the Osmundaceæ; Dr. Scott, on a primitive type of structure in *Calamites*; Prof. F. W. Oliver, on the structure of certain Palæozoic seeds; Mr. Seward, Jurassic floras; the structure and origin of jet; Mr. Arber, a collection of fossil plants from New South Wales; Dr. F. F. Blackman and Miss Matthaei, autosurgery in leaves; on respiration; Miss Clark, effect of altered conditions of growth upon *Lemna* roots; Mr. Tansley, the vegetation of Mount Ophir; Mr. Yapp, some botanical photographs from the Malay Peninsula; Miss Clark, abnormal secondary thickening in *Kendrickia Walkeri*; Mr. Worsdell, the structure and morphology of the flowers of *Cephalotaxus*; the morphology of the ovule; Mr. Tagg, museum work; Mr. Borthwick, increment of wood; Mr. Gwynne-Vaughan, the vascular anatomy of the Cyatheaceæ; on the nature of the stele of *Equisetum*; Mr. Boodle, remarks on the stele and foliar bundles of ferns.

The new section of Educational Science will be opened on the morning of September 12 with an address by the president, Sir John Gorst. In the afternoon there will be papers and discussions on the organisation of education in Scotland and particularly in Glasgow. On September 13, papers on the science of education will be read by Prof. Armstrong, F.R.S., Prof. Miall, F.R.S., Prof. Withers and others. On Monday, September 16, a discussion on the teaching of mathematics will be introduced by Prof. Perry, F.R.S. On September 17 the subject of discussion will be the influence of universities and examining bodies on the education given in secondary schools, introduced by the Bishop of Hereford and Mr. H. W. Eve.

The committee of the Marine Biological Association of the West of Scotland invite members of the Association who are interested in marine biology to work at or visit the Marine Station, Millport, N.B., any time during September 1901, and to join any of the open collecting excursions of the steam yacht *Mermaid* during that month. The intention should be communicated to the Curator, Marine Station, Millport, N.B.

THE INTERNATIONAL ZOOLOGICAL CONGRESS.

THE fifth International Congress, the proceedings of which have just terminated in Berlin, has, notwithstanding the depression caused by the recent death of the Empress Frederick, been a brilliant and important reunion, whether judged by the number and status of the zoologists present or by the interest of its work.

The meetings were held in the Reichstagsgebäude, corresponding to our Houses of Parliament, a fact which in itself testifies to the esteem in which science is held in Germany.

On the evening of Sunday, August 11, an informal gathering was held at which the delegates and members were able to meet and greet each other, to renew old acquaintances and form new ones. The business of the Congress began on Monday, August 12, in the large hall of the Reichstag, when Prof. Möbius assumed the presidential chair and, after declaring the proceedings open, made a touching reference to the sorrow which had fallen upon the Royal Family, and proposed that telegrams of condolence should be sent to the Emperor and to the Crown Prince, who had graciously consented to act as patron of the assembly. Replies to these messages were subsequently received and read.

The Congress was then welcomed by His Excellency Herr Rothe, Under Secretary of State, in the absence of the Chancellor, by Burgomaster Kirschner and by Prof. Harnack, the Rector of the University. Prof. Perrier expressed the acknowledgments of the foreign delegates, and after some formal business, Prof. Grassi, of Rome, delivered a lecture on "The Malaria Problem from the Zoological Point of View," in which he gave an account of the diseases caused by insect-stings and dwelt upon the importance of their study for the progress of hygiene.

It is usual with us to terminate the proceedings of a congress with a picnic, but the committee charged with the arrangements of the present meeting seem to have thought that the proceedings would be smoother if social intercourse preceded debate, and with this view organised an excursion to the Havel See.

On the Tuesday no forenoon sittings were held, in consequence of the Royal funeral; but at midday a general meeting was held, at which, among other business, it was announced that the prize offered by the Emperor Nicholas II. had been awarded to Dr. Oudemans, of Amsterdam, for his memoir "On the Influence of Light on the Development of Colours in the Lepidoptera."

Dr. Sclater having taken the chair, lectures were delivered on "The Theories of Fertilisation," by Prof. Yves Delage (Paris), who referred to the importance of studying the phenomena, not merely morphologically, but also physiologically; and on "The Psychic Faculties of Ants and other Insects," by Prof. Forel (Morges), in which he sought to show an identity between the senses of insects and our own and to demonstrate their possession of memory, association of sensory impressions and power of drawing conclusions from experience.

A general meeting was also held on Thursday afternoon, August 15, when addresses were given by Prof. E. B. Poulton (Oxford) on "Mimicry," by Prof. Patten (Hanover, U.S.A.) on "The Origin of Vertebrates," Prof. v. Zograf (Moscow) on "Hydrobiological Investigations and Institutes in Russia," M. A. Pizon (Paris) on "The Observation of Budding in Tunicates," Mr. C. G. Schillings (Düren) on "East African Mammals," and Mr. O. Neumann on "Results of a Journey from the Red Sea to the White Nile," all illustrated by the lantern.

At other times the Congress separated into seven sections—viz. General Zoology, Experimental Zoology, Vertebrata (Biology, Classification), Vertebrata (Anatomy, Embryology), Invertebrata, Arthropoda and Nomenclature. These were presided over on successive days by different zoologists of eminence, and such numerous communications were made to each that it is impossible to give an account of these, or even a list of their titles.

The concluding meeting took place on Friday morning, when a large amount of business was transacted. The report of the Nomenclature Commission, which was adopted, included a recommendation that specific and generic names should be amended only when a printer's error or a mistake in orthography could be proved, and that in all cases the first name given to an animal, whether to the whole animal or to a part, to an adult or a larva, should stand, and also a proposal for introducing uniformity into the arrangement of figures on plates and the designation of their parts by explanatory letters. Resolutions were also passed in favour of the preservation of non-injurious animals and the formation of a section for zoogeography; it was, further, decided to hold the next congress in Bern, under the presidency of Prof. Studer. Addresses were given by Prof. Bütschli (Heidelberg) on "Vitalism and Mechanism," and by Prof. Branco (Berlin) on "Fossil Men," and after the usual complimentary resolutions the Congress was adjourned.

Such were in brief the formal proceedings, but, as is always the case, these were by no means the most important results. More far-reaching in their influence on the life and work of zoologists are the informal discussions and friendly conversations which take place in the intervals, on such occasions as the reception by the City of Berlin at the Rathhaus, by the Zoological Society in its magnificent garden and in other more modest convivial gatherings.

The whole meeting was admirably organised, with German thoroughness and attention to detail. It only remains to be added that an appendix to the Berlin meeting took place in Hamburg, where the members were received at the Rathhaus by the Senate of the City, by the directors of the Hamburg-American Line on board the ss. *Graf Waldersee* and by the Zoological Society in their garden. A trip to Heligoland terminated the whole proceedings, which must have left a vivid and pleasant impression on the mind of every one present.

CHARLES A. SCHOTT.

MR. CHARLES A. SCHOTT, whose death we regret to record, was renowned throughout the world of physical science on account of his numerous memoirs on terrestrial magnetism. The work accomplished by him during a long and active career was both extensive and influential, and its value has long been recognised by physicists in both hemispheres.

From an appreciative account of Mr. Schott's work, which appeared in *Terrestrial Magnetism* two years ago, we learn that he was born at Mannheim, Baden, Germany, August 7, 1826. After passing through the public school and partly through the Lyceum of his native town, he entered the Polytechnic School at Karlsruhe, where, after a six-year course, he graduated as civil engineer in 1847. In December of that year he entered the service of the United States Coast Survey, and in due time became a citizen of the United States. At first he was engaged in office and nautical duties, but he was assigned to the position of Chief of the Computing Division of the Survey in 1855. Mr. Schott continued in charge of this until the end of 1899, and he then undertook the discussion of the arc measurements in the United States resulting from the extension triangulation already executed by the different organisations engaged in survey work. A summary of some of the results of this work was given in NATURE of February 21 (vol. lxiii. p. 408).

Mr. Schott's numerous contributions to the annual reports of the Coast Survey since 1854 relating to hydrography, geodesy, practical astronomy, and especially to terrestrial magnestism, are well known. He also published through the medium of the Smithsonian Institution, between the years 1858 and 1881, a number of memoirs bearing on meteorology and on subjects relating to Arctic explorations. He was a member of the Government parties sent to Springfield, Illinois, to observe the solar eclipse of August 1869, and to Catania, Sicily, to observe that of December 1870. As delegate from the United States Coast and Geodetic Survey, he attended the International Conference on Terrestrial Magnetism, held at Bristol in 1898 in connection with the meeting of the British Association. In the same year he received the Henry Wilde prize of 4000 francs from the Paris Academy of Sciences for his numerous contributions to terrestrial magnetism. This was the first award of the prize; and the President of the United States in making the presentation alluded to the catholicity of scientific work and the recognition of distinguished merit implied in the fact that Mr. Schott—an American—should be awarded by French men of science a prize founded by an Englishman. It is encouraging to know that Mr. Schott's zeal and industry for the advancement of natural knowledge met with recognition in the world of science.

NOTES.

A COMMITTEE has been appointed by the President of the Board of Trade to inquire and report as to the best means by which the State or local authorities can assist scientific research as applied to problems affecting the fisheries of Great Britain and Ireland. The members of the committee are as follows:—The Right Hon. Sir Herbert Maxwell, Bart., M.P., Mr. Walter E. Archer, Mr. Donald Crawford, Rev. William Spotswood Green, Prof. William Abbott Herdman, F.R.S., the Hon. Thomas H. W. Pelham, Mr. Stephen E. Spring-Rice, C.B., and Prof. J. Arthur Thomson.

IT has been decided to erect in Leoben, Austria, a statue of Peter Ritter von Tunner, who died on June 8, 1897, to commemorate his great services to the metallurgy of iron. An influential committee has been formed, with Mr. Ignaz Prandstetter as president, Prof. J. G. von Ehrenwerth as vice-president and Prof. Carl Fritz as honorary secretary, to collect subscriptions. At a recent meeting of the council of the Iron and Steel Institute the matter was considered. As a contribution to the memorial could not be voted from the funds of the Institute, the members of council present decided to contribute two guineas each, and Mr. Bennett H. Brough, the secretary, now informs us that he has forwarded to the committee in Leoben contributions of that amount from twenty-six members.

A REUTER message records that the *Lucania*, which left Liverpool on August 10 for New York, was spoken by wireless telegraphy at Nantucket Lightship shortly after 6 p.m. on August 16. The following message, signed by Captain McKay, was among those received on the lightship from the *Lucania*, and then transmitted forty miles to Siasconset, on Nantucket Island:—"All well on board. We are 287 miles from Sandy Hook, with clear weather, and expect to reach New York on Saturday. Please inform Cunard Agents." On reaching port the officers of the *Lucania* reported that the messages from Nantucket were undecipherable aboard ship.

WE learn from the *Athenaeum* that Dr. Trootz, the Belgian Minister of the Interior, who is also Minister of Education, has proposed in the Chamber the foundation of a *Belgica* prize for the promotion of oceanic researches by Belgians, and that the prize shall be allotted at the discretion of the scientific class of the Academy. The sum of 41,000 francs, which will constitute the nucleus of the projected prize, has been obtained by the sale of the *Belgica*, the ship of the Belgian South Polar Expedition, to the Norwegian Government. Lieut. Gerlache, who was the leader of the expedition, suggests, on the other hand, that the capital of 41,000 francs should be put out to interest until the fund amounts to 100,000 francs, and that the interest should then be expended upon grants to Belgian oceanic explorers, and also upon a *Belgica* medal, to be bestowed upon polar explorers of all nations. It is reported that the Minister is now inclined to support Lieut. Gerlache's two suggestions.

A STRIKING example of the improvements which have been made in the mechanical arrangements for the loading of coal from railway trucks into vessels has recently been afforded by a new hydraulic coal hoist which has been erected at the Penarth dock. A steamer arrived in the dock at 8.10 in the morning. After taking in sufficient coal for her boilers she proceeded to load her cargo at 9.15, which was completed at 11.50, the steamer entering and leaving the dock on the same tide. The quantity of coal placed in the vessel was 2333 tons, in two and a half hours, or at the rate of about fifteen tons a minute.

THE next meeting of the International Navigation Congress is to take place at Dusseldorf from June 29 to July 6, 1902. The subjects that will be specially considered are (1) as regards inland navigation; lifts; lifts on inland waterways; the transport of coal. Communications are invited on the construction of reservoir dams; improvements in the mechanical propulsion of vessels; utilisation of water-power at weirs for electric propulsion. (2) Ocean navigation; construction of iron and wooden gates for locks; the use of sea-going lighters; construction and management of graving docks and repairing slips; construction and cost of dredging machinery.

A PROJECT is now under consideration by the municipality of Vienna for disposing of the sewage of the city, which at present is discharged into the Danube. The scheme consists in the application of a method developed by Herr Noebel, of Posen, for the utilisation of the liquid part of the sewage for the double purpose of irrigation and manure. It is intended to convey the sewage in pipes to an extensive plain of poor land which suffers from a lack of water, due to inadequate rainfall, over which it is not to be carried in trenches, as is done in this country, but the surface of the land is to be irrigated by sprinkling the sewage water over it. It is contended that by this system the land will not be over-saturated, as it frequently is on the sewage farms at Berlin and Paris. The system is stated to have been already in use at Posen, with satisfactory results.

PROF. FREDERICK STARR, who for several years has closely studied the physical types of the tribes of southern Mexico, has, says *Science*, just brought his work to a close. Three kinds of work were done—measurement, photography and modelling. In each tribe one hundred men and twenty-five women were measured, fourteen measurements being taken of each individual. Photographic portraits were taken of typical subjects, a front view and a straight profile being made of each. Busts in plaster were made of those who appeared most perfectly to present the racial type, the moulds being made directly upon the subject. During the four seasons over which his work has extended, Prof. Starr has visited twenty-three tribes. While the physical types of the natives formed the chief subject of study, many views were also taken of the scenery, villages, houses, groups of Indians, native industries, &c. The material results of the investigation include measurements from 2850 persons, 1200 or more negatives, varying in size from 8 × 10 inches to 4 × 5, 100 busts in plaster and a large collection of objects—dress, weapons, implements and products—illustrating the ethnography of the region. Several months will be necessary for putting all this material into shape for exhibition and publication.

THE Deutsche Seewarte has published, as an appendix to the August number of the *Annalen der Hydrographie*, a useful collection of storm tables for the Atlantic Ocean. For some years the Seewarte has been collecting and publishing notices of storms, giving, in a very concise form, the time, position and duration, the reading and motion of the barometer (rising or falling) and the various changes of the wind (backing or veering). The results have been arranged in tabular form, in twenty-two districts, according to months and seasons, and grouped under four principal points of the compass. The chief object of the tables is to show at a glance if, on the occurrence of bad weather (when the wind force has reached a fresh gale), there is a prospect of it becoming worse, what the probable further behaviour of the storm will be. The explanatory text contains useful remarks respecting the general distribution and characteristics of storms in different seasons and in various localities of the Atlantic.

AN important publication, just issued by the Department of Revenue and Agriculture of the Government of India, brings together the agricultural statistics of British India and of the Native States, so far as they can be procured, for the five years 1895–6 to 1899–1900. The first thirty pages are explanatory. The bulk of the volume consists of tables of figures, giving the areas of cultivated and uncultivated land; the areas under each crop (the irrigated and not irrigated separately mentioned); the average yield of the principal crops; the number of farm animals, ploughs and carts; the statistics of land revenue assessment, and of transfers of land, for each separate district in the empire. The information will be of the greatest value to those who have the task of developing the resources of the country. The general summary of the acreage described for the year 1899–1900 is as follows:—

	British India, Acres.	Six Native States, Acres.
Total area surveyed	544,858,070	45,952,429
Under forest	65,843,924	3,087,209
Unculturable	135,506,014	11,374,311
Culturable waste	106,404,704	9,765,998
Fallow land	57,163,761	5,452,596
Sown with crops	180,151,093	10,385,927
Irrigated	31,544,056	1,357,463

THE Report on the Observatory Department of the National Physical Laboratory for the year 1900 has been published in the *Proceedings* of the Royal Society. The magnetographs have been in constant operation throughout the year, but the curves have been quite free from any large fluctuations. The mean westerly declination for the entire year was 16° 52'·7. The automatic and tabulated records of the various meteorological instruments have been transmitted, as usual, to the Meteorological Office, to be dealt with in its publications, and special cloud observations have been made each month in connection with the international scheme of balloon ascents. Seismological observations have been regularly made; two noticeable disturbances occurred during the year, on January 20 and October 29. A detailed list of the movements of the seismograph will be published in the Report of the British Association for the present year. As regards experimental work, the observation of distant objects during mist and fog and researches upon atmospheric electricity, referred to in previous reports, have been regularly continued. The list of the various instruments tested is a very long one; we therefore select only a few of the principal cases in which a considerable increase has occurred:—Aneroids and marine barometers (number tested in year 1900), 336 (increase 69); compasses, 963 (increase 559); rain gauges, 1345 (increase

784); clinical thermometers, 20,476 (increase 4456); total number of instruments tested, 27,569 (increase 5518). The principal addition to the staff during the year has been the appointment of Dr. J. A. Harker as an assistant in the Laboratory. Among the different appendices may be mentioned one showing the mean values of the magnetic elements at observatories the publications of which are received.

THE first number has reached us of the "University of Missouri Studies," a publication which it is proposed to issue as irregular intervals as often as work of the required standard it offered by members of that University. The present number consists of "Contributions to a Psychological Theory of Music," by Dr. Max. Meyer, professor of experimental psychology.

PROF. ANGELO ANDRES, writing in the Lombardy *Rendiconti*, discusses the choice of a base line in the so-called "rational" measurement of animals according to which the various dimensions are expressed in terms of one measurement, generally representing the length of the animal. As a result of the considerations brought forward by the author, the distances which best satisfy the requirements in the selection of the base fall, in the case of vertebrate animals, into six groups, according to the particular class of animals considered.

A STUDY of the nummulites of southern Italy has been made by Dr. Giuseppina Gentile, chiefly from observations of specimens in the geological museum of the University of Naples. The examples which the authoress describes, belonging to twelve species and five varieties, come from the Middle and Upper Eocene formations, the former being represented by a prevalence of the forms *N. laevigata, N. lucasana and N. perforata* and the latter strata being characterised similarly by a prevalence of *N. Tchihatcheffi* and *N. Guettardii.* The paper is to appear in the *Atti* of the Naples Academy.

WITH the object of conducting researches in limnology in Italy similar to those instituted in Switzerland by Forel, the Reale Istituto Lombardo appointed in 1896 a committee to investigate the variations of temperature in the lake of Como, and a preliminary report appears in the *Rendiconti* of the Academy, xxxiv. 11. The western limb of the lake is particularly suitable for such observations, on account both of the regularity of its basin and, more especially, on account of the absence of any fluvial current of importance. The vertical distribution of temperature is in conformity with the measurements obtained by Burguières and Forel. In connection with the annual variations, the most remarkable feature (observed in two consecutive years) was the irregular undulation of the curves at depths of twenty and thirty metres, and in particular the appreciable cooling which at these depths occurs in the hottest months. Observations have also been made on the variations of long period, and on the horizontal distribution of temperature across various sections of the lake.

THE *Journal* of the Royal Microscopical Society for August contains the full report of the paper to which we have already alluded, by Mr. J. W. Gordon, on the Abbe diffraction theory, very fully illustrated by a large number of diagrams. The main point of Mr. Gordon's contention is that the diffraction effects seen in the use of Zeiss's *Diffractions Platte* are produced by the diaphragm itself. He maintains that the diffraction theory has virtually been abandoned by Prof. Abbe himself. In the discussion which followed, in which Prof. S. P. Thompson and Mr. Julius Rheinberg took part, and which is also reported in full, the prevalent view appeared to be that while Mr. Gordon had successfully exposed the incorrectness of some of the statements of Naegeli and Schwendener and of other exponents of the theory, he had not succeeded in showing that these errors were the necessary consequences of the theory.

M. BLONDEL concludes his paper on oscillographs and their use in the current number of the *Revue générale des Sciences* with an account of his work on the alternate current arc. The paper contains a number of very interesting oscillograph curves—the first to be published of those taken by Mr. Blondel's double oscillograph—showing the variation of current and potential difference with an alternate current arc between carbons or between carbon and metal. The general characteristics of these curves are now fairly well known, either through the previous papers by M. Blondel or through the exhaustive series of waveforms in Mr. Duddell's paper in the *Journal* of the Institution of Electrical Engineers (vol. xxviii. p. 1). Greater interest attaches, therefore, to the curves showing the effect of an alternating current superimposed on a direct current arc. The form of these curves throws important light on the much-discussed "negative resistance" of the arc. The curves published by M. Blondel lead him to the conclusion that the value of dV/dA is very small, positive for cored and negative for solid carbons. This ratio, the negative value of which, found by Messrs. Frith and Rodgers, gave rise to the controversy alluded to above, is defined by M. Blondel as "the coefficient of stability," which seems to us a very convenient term.

A REPORT by Prof. T. E. Thorpe, C.B., F.R.S., on the work of the Government Laboratory upon the subject of the use of lead compounds in pottery, has been published as a Parliamentary paper. It may be remembered that a detailed report upon the use of lead compounds in the production of pottery glazes and colours was prepared by Profs. Thorpe and Oliver in 1899, and the conclusions were described in these columns (vol. lx. p. 18). Since the publication of that report a large number of further experiments have been made upon lead fritts and upon glazes containing their lead in the form of lead fritt, and a second paper was issued a short time ago. The present paper embodies chemical evidence which Prof. Thorpe has to offer in connection with the special Rules drawn up for potteries as to the use of fritted lead and its degree of insolubility. Fritted lead is a silicate or borosilicate of lead formed when "raw" lead, that is, red lead, white lead or litharge is fused or fluxed with a part or the whole of the silica, or of the silica and the other materials used for the glaze. Potters agree that fritted lead can be substituted for raw lead in every section of pottery manufacture, and it was thought by the Department Committee (1893) on lead poisoning that this would mitigate the evil, then very prevalent. But there are different kinds of fritted lead depending upon the proportions of the materials taken. Some lead fritts appear to be little less soluble in dilute acids than raw lead, and therefore have just as injurious an effect when they find their way into the system of the potter and are dissolved by the gastric juice. Other fritts are nearly insoluble and therefore innocuous. It is to ensure the use of such insoluble, or slightly soluble, fritts that the efforts of the Home Office are now directed. Practical difficulties have, however, arisen as to the standard and tests of solubility, and Prof. Thorpe's report deals chiefly with the objections which have been raised to the proposed Rule on scientific grounds.

DR. R. W. SHUFELDT, in the *American Naturalist*, discusses the osteology and systematic position of the auks and puffins. After reviewing the various arrangements proposed by other writers, the author considers that these birds should form a suborder (= order of most ornithologists), the Alcæ, which is connected, on the one hand, with the plover group through the gulls and their allies, and on the other, through the petrels, with the penguins, loons, grebes and their extinct toothed ally, Hesperornis. In reality, this arrangement is not very different from the one proposed years ago by Dr. Sclater, who placed the auks and loons in a single order (Pygopodes), flanked on the one side by the petrels and on the other by the penguins.

THE July issue of the *American Naturalist* opens with a continuation of Mr. W. H. Wheeler's account of the compound and mixed nests of American ants, the present section dealing with the instances of "social symbiosis." No less than eight different types of this association are recorded, for each of which a special term is adopted. Plesiobiosis, for instance, indicates the cases where ants of two (rarely more) species, which are generally inimical to each other, excavate their galleries in close contact. Xenobiosis, on the other hand, refers to the so-called guest-ants, which maintain independent households among their hosts, with whom they may be on terms of toleration, or even friendship; while Dulosis is applied to cases where one species of ant is kept in slavery by another. The paper teems with interest to students of ant-life.

THE important series of descriptive catalogues recording the collections made by the Royal Indian Marine Survey ship *Investigator* has been enriched by the appearance of "A Descriptive Catalogue of the Indian Deep Sea Crustacea Decapoda Macrura and Anomala." In his preface the author, Major A. Alcock, states that although most of the new species obtained during the dredging cruises of the vessel under his direction have been described in earlier publications, the present volume must not be regarded as a mere reprint of such reports. It contains definitions of the larger groups under which the species are arranged and also valuable tables of distribution, as well as a considerable amount of material prepared by the author as the basis of a larger work on Indian crustaceans. Out of a total of 117 species of Macrura (lobsters, crayfish, shrimps, &c.) obtained during the various cruises, sixty-nine are believed to be peculiar to Indian waters. Most were obtained in less depths—mostly much less—than 1000 fathoms; and out of eleven dredged from deeper water, only five appear to be truly abyssal, several of the others being taken in the net during its ascent. The Anomala present a greater percentage of deep-sea forms, eight out of fifty-two being abyssal types.

DESPITE an unfortunate falling-off in the income, the Report of the Manchester Museum for 1900–1 tells of continued progress of that institution. Owing to the generous presentation of his collection by Mr. P. Schill, which is especially rich in Eastern Holarctic forms, the Manchester series of Lepidoptera now occupies a foremost position among provincial cabinets. The director has also to report the presentation by Mr. R. D. Darbishire of a shell of *Pleurotomaria adansoniana* from Barbados; and the purchase of duplicate shells from the Layard collection has been a most satisfactory investment, the sale of superfluous specimens having repaid the entire cost, while more than 2000 examples have been added to the Museum series. The herbarium has also been largely increased. Neither has the exhibition series been neglected, the director calling especial attention to the display of the various groups of worms, as well as to the dissections and drawings illustrating the anatomy of molluscs.

WE have much pleasure in congratulating the Field Naturalists' Club of Victoria on its "coming of age," an event which was duly celebrated in Melbourne on June 25. In calling attention to the present condition of the Club, the committee were able to report, in spite of increased expenditure, a slight improvement in the finances and also an increase in the roll of members. During the year the Club has called attention to the destruction of various species of "wattle" (*Acacia*), and also to the spread of the water-hyacinth and iris—it is hoped with good results. Among other papers, the July issue of the *Victorian Naturalist* contains one describing the curious incrustations formed on roots in the littoral sand-dunes of certain districts. The theory that these are formed by the action of vegetable acids on the lime contained in the sand is confirmed. By the decay of the contained root and the percolation of calcareous matter these incrustations may become solid throughout.

THE occurrence of chrysoberyl in the gneiss of Manhattan Island, New York City, is recorded in a pamphlet published by Mr. W. G. Levison (New York, 1901).

AN article in the *Pioneer Mail* of July 5, 1901, deals with the important question of artesian wells for India, and it is urged that the Imperial Government should undertake a series of borings. Mr. Griesbach, the Director of the Geological Survey of India, has suggested that a search for artesian water might be made in the flat country enclosed by Mahi Kantha on one side and Kathiawar on the other in Gujerat proper. If successful the wells would be useful in the northern division of Bombay.

A PRELIMINARY report on the Cape Nome gold region on the south-western coast of Alaska has been prepared for the United States Geological Survey (1900) by Mr. F. C. Schrader and Mr. A. H. Brooks. In this region the bed-rock consists of altered limestones, mica schists and gneisses, and above it are various gravels forming beaches and terraces, which occur in the gulches (creeks) and valleys and also over the tundra. It is remarked that the gulch and beach placers are extraordinarily rich in gold, and the metal is also known to occur in the bars of the larger rivers and in the tundra. No bed-rock mining has been done, but as the gravels and gold are largely of local origin, workable veins may eventually be found. The authors observe that the staking of new claims "is probably nearly a thing of the past, yet those having capital to invest will undoubtedly find plenty of claims for sale." They add, "it would be very wise for all inexperienced newcomers to save money for the return passage."

A NEW scientific journal, the *Allgemeine Naturforscher-Zeitung*, will be published in Berlin early in October. The prospectus states that the journal will be "die erste naturwissenschaftliche Zeitung der Welt."

A SECOND edition of the second report of the United States Board on Geographic Names has been received, and with the exception of a few minor corrections it is the same as the original edition of May, 1900. The general policy of the Board has been to adopt the name which is in common local use at present, but local usage has been neglected in some cases in order to effect reforms in nomenclature. Among these departures approved by the Board are the following:—the avoidance, so far as practicable, of the possessive form of names; the omission of the final "h" in the termination "burgh"; the abbreviation of "borough" to "boro"; the spelling of the word "centre" as "center"; discontinuance of the use of hyphens in connecting parts of names; the simplification of names consisting of more than one word by their combination into one word; the avoidance of the use of diacritic characters; the omission of the words "city" and "town" as parts of names. Evidently these principles have their limitations, and the Board recognises the practical impossibility of inducing English people to speak of Germany as Deutschland, Turin as Torino, or The Hague as 's Gravenhage. It is suggested, however, that the adoption of the home name "is a reform to which we may look forward and work toward, and which may be attained in the future." Each name must evidently be considered separately, and the Board exists to do this and to decide what name shall be adopted. The present report contains all decisions rendered by the Board from its creation to April, 1900.

THE additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas*) from West Africa, presented by Mr. U. R. Noble; two Bonnet Monkeys (*Macacus sinicus*) from India, presented respectively by Mrs. Noble and Miss Weil; two Ring-tailed Coatis (*Nasua rufa*) from South America, presented respectively by Mr. Charles North and Mr. E. F. Johnston; two White-tailed Gnus (*Connochaetes gnu*) from South Africa, presented by Mr. C. D. Rudd; an Osprey (*Pandion haliaetus*) captured at sea, presented by Commander H. Strong; a Toco Toucan (*Ramphastos toco*) from Guiana, a Red-billed Toucan (*Ramphastos erythrorhynchus*) from Cayenne, a Hutchin's Goose (*Bernicla hutchinsi*) from Arctic America, presented by H.E. Sir W. J. Sendall, G.C.M.G.; two Infernal Snakes (*Boodon infernalis*), six Rufescent Snakes (*Leptodira hotambaeia*), six Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), five Crossed Snakes (*Psammophis crucifer*), two Rough-keeled Snakes (*Dasypeltis scabra*) from South Africa, presented by Mr. A. W. Guthrie; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Miss Wilson; an Eyed Lizard (*Lacerta ocellata*), a Tessellated Snake (*Tropidonotus tessellatus*), South European, presented by the Rev. F. J. Jervis-Smith, F.R.S.; a Brindled Gnu (*Connochaetes taurina*) from East Africa, purchased.

OUR ASTRONOMICAL COLUMN.

NOVA PERSEI.—A telegram from Kiel announces that photographs of Nova Persei, taken on August 19 and 20 by MM. Flammarion and Antoniadi, show a nebulous aureola having a definite sharp outline.

PERIOD OF MIRA CETI.—Prof. A. A. Nijland finds from a series of thirty-nine observations of this long-period variable during the interval July 17 to September 11, 1900, that the maximum occurred last year on August 3. As will be seen from the table below, this brings the period back to the short value of 1897. (*Astronomische Nachrichten*, Bd. 156, No. 3733.)

Observed maximum.	Predicted (Chandler III.).	Magnitude.	Period.
1897 Jan. 11	1896 Dec. 12	3·70	
			319 days
1897 Nov. 26	1897 Nov. 9	3·24	
			312
1898 Oct. 4	1898 Oct. 6	2·91	
			350
1899 Sept. 19	1899 Sept. 3	3·75	
			318
1900 Aug. 3	1900 Aug. 1	3·35	

THE CAPE OBSERVATORY.—The annual report to the Admiralty has recently been issued by Sir David Gill, and summarises the work done at the institution during the year 1900.

The new transit observatory is now satisfactorily erected. It is of sheet steel, having triple sides, thus forming a double series of ventilating shafts, arranged so as to carry off all heated air by convection and deliver it by funnels 13 feet distant from the observing shutter; this latter is 6 feet wide, formed by the two halves of the building sliding apart.

The upper part of the structure is semicylindrical, its axis coinciding with that of the transit circle. It is hoped that this symmetry between building and instrument will eliminate abnormal refractions. The double-chambered walls have made it possible to attain practical equality between the external and internal temperatures.

Transit Circle.—Much of the transit circle work has consisted of a thorough investigation of the influence of "star magnitude" on the observers' personal equations. The results are given in detail, and indicate that, while there is considerable range in magnitude personality for different observers, every observer records the time of transit of a faint star later than that of a bright one, and also, as a rule, this personality is greater "per magnitude" for faint than for bright stars. Another somewhat unexpected fact brought out by the investigation is that the difference of personality remains nearly the same for stars of very different declination.

Heliometer.—Regular observations of all oppositions of major planets have been continued—of these fifty-three related to Jupiter, forty to Saturn, forty-four to Uranus and sixty-six to Neptune. Observations were also made of the conjunction of Jupiter and β Scorpii, and of the distances of the cusps of the partially eclipsed sun on November 22, 1900.

McClean Equatorial.—The 24-inch photographic objective has been refigured and forwarded to the Cape from Dublin. The 18-inch visual telescope has been employed in the observation of double stars, thirty-one previously unrecorded pairs being found, nine of which are naked-eye stars.

In consequence of the absorption of the three heavy flint prisms belonging to the "line of sight," spectrograph they have been replaced by four of lighter glass giving the same total deviation. Mr. McClean, who is providing these, has also generously given an order to Messrs. Zeiss for a second objective prism of 24 inches aperture and 10° refracting angle.

Physical Laboratory.—Investigations have been in progress by Mr. Lunt dealing with the spectra of oxygen, silicon, aluminium, boron and sulphur, and provision is being made for a further study of the spectra of various gases.

Astrographic Charts and Catalogue.—One hundred and three triple image chart plates have been passed, bringing up the total to 362. For the revision catalogue, 172 plates have been taken. During the year, 124 catalogue plates, containing 71,655 stars, have been completely measured in both coordinates in reversed positions of plate.

South African Survey.—This has been pushed rapidly forward in Rhodesia, the party reaching latitude 16° 30′ S., and they expected to reach the Zambesi by the end of July. The operations for the Anglo-German Boundary Survey are also in steady progress. It is hoped that arrangements will soon be possible for the extension of the survey through the international territories north of Rhodesia, thus bringing the long-wished-for African arc of meridian nearer to practical realisation.

OBSERVATION OF COMET *a* (1901).—Mr. J. Cresswell, writing from a mining camp near the centre of Borneo, sends a drawing of this comet, which was visible there on May 7–12. He says:—"It was very bright, and had two tails which on May 10 were 29½° apart and on May 12 35° apart. The lower tail was less bright than the upper. I looked for it during the solar eclipse, but did not see it." Further observations were prevented by cloud.

THE AUGUST METEORS OF 1901.

THE weather was tolerably clear near the time of the maximum and enabled the shower to be pretty well observed. On August 10, 11 and 12, or on one or two of those nights, a considerable number of meteors were recorded at various places where the clearness of the sky permitted observation. The maximum appears to have occurred rather later than usual, for the greatest number of meteors displayed themselves on Tuesday morning, August 13, but the state of the sky did not allow the progress of the display to be fully observed during its rise, culmination and fall.

The first marked indication of the Perseids as a definite shower became apparent on July 21, when the writer at Bristol recorded five swift streak-leaving meteors from a radiant at $23° + 52°$, but two of them were imperfectly seen and their directions could be only roughly noted, so that the resulting radiant was not very satisfactory, though there could be no doubt of its actual existence either at or very near to the position assigned.

Between July 21 and August 10 the development of the shower could not be fully traced, owing to moonlight or cloudy weather. On August 10 the display was moderately rich. There was no special activity on the part of the Perseids, but the minor showers of the period were in prominent evidence and provided meteors as fast as the observer found it convenient to record them. Between about 9h. 30m. and 15h. the total number of meteors seen by the writer at Bristol was 102, but nearly half of the time mentioned was consumed in registering paths. While the observer's attention was, in this manner, diverted from the sky, a large number of meteors must have eluded notice; of the 102 seen 55 were Perseids.

On August 11 the sky was clear until after midnight, and between 9h. 30m. and 12h. 30m., 72 meteors were noticed, of which 49 were Perseids. As compared with the previous night the Perseids had increased, while the other meteors exhibited a marked decrease. Clouds prevented further observation at 12h. 30m.

On August 12 the sky was overcast, but between 14h. and 14h. 30m. there was a break along the east and south-east horizon, through which a few of the stars could be seen. Meteors were numerous, and it was considered that with a clear sky the display would have been unusually fine.

A few cloudy nights intervened, but on August 15 and 16 observations were secured during clear intervals. The Perseid shower was still actively in play, and supplied about one-third of the aggregate number of meteors visible. On August 18 the sky was watched between 9h. 30m. and 14h. 15m., but meteors, generally, were extremely rare. The Perseid shower furnished eight paths, so that the display was still well defined. On August 19, observations were made between 9h. 30m. and 15h., and 40 meteors were seen, of which 3 only were Perseids, so that the stream had become nearly exhausted. The radiant point was determined from several well-observed paths on each night, and its easterly position as compared with its place on August 10 and 11 was strikingly evident. Between July 21 and August 18, its R.A. differed to the extent of 32°, as the following figures will prove:—

July 21	... $23° + 52°$	...	5 meteors
Aug. 10	... $44 + 58$	...	55 ,,
11	... $45 + 58$	...	49 ,,
15	... $51 + 58$	...	6 ,,
16	... $53 + 58$	...	5 ,,
18	... $55 + 59$	...	8 ,,

The Perseids furnished some brilliant specimens, but there was only one fireball seen by the writer. This appeared at 11h. 2m. on August 11, and lit up the south-eastern sky with a lightning-like flash. It was seen also at Birmingham and Yeovil, and its height is given in the table. The largest meteors recorded at Bristol were as below:—

	h.	m.		From	To	
Aug. 10 ...	12	47	♃	$331\frac{1}{2}° + 6\frac{1}{2}°$ ...	$324\frac{1}{2}° - 6\frac{1}{4}°$ ...	swift stk.
...	13	0	♃	$33 - 4$ ...	$32 - 12$ ...	v. swift stk.
...	13	$17\frac{1}{2}$	>♃	$333 + 60$ ...	$302 + 45\frac{1}{2}$ ...	v. swift stk.
...	13	33	1	$62 + 22\frac{1}{2}$ ...	$66 + 11\frac{1}{2}$ ...	v. v. slow.
Aug. 11 ...	11	2	2×♀	$353\frac{1}{2} + 7$ ...	$343 - 14$ ...	v. swift stk.
...	11	34	♃	$43 + 79$ ...	$232 + 73$ ...	sw. b. stk.
...	11	56	♀	$120 + 74$ ...	$160 + 65$ ...	sw. stk.
12 ...	14	4	♃	$46 - 5$ ...	$46 - 15$ ...	sw. stk.
19 ...	14	5	♃	$322 + 48\frac{1}{2}$ ...	$338\frac{1}{2} + 41$ ...	v. slow train.

Four meteors seen on August 10 were also recorded by Prof. A. S. Herschel at Slough, and their real paths have been determined. Their heights, &c., are included in the following table, in which are also given the results for the fireball of August 11, which left a streak for about a minute amongst the stars of Aquarius. It must have been a magnificent object from the English Channel:—

	h. m.	mags.	Height at first miles.	Height at end miles.	Path miles.	Velocity per sec. miles.	Radiant
Aug. 10 ...	10 41	3 – 2	91	72	20	24	$278° + 67°$
	12 0	1	76	51	36	50	$44 + 58\frac{1}{2}$
	12 16	2 – 1	69	50	27	39	$42 + 57$
	12 19	3 – 2	72	60	33	25	$149 + 60$
Aug. 11 ...	11 2	2 × ♀	95	56	64	...	$45 + 58$

The latter object began over the channel at a point about 25 miles W. of Dieppe, and ended a little W. of Havre on the French coast. It would be interesting to hear further descriptions of it from the channel and from the north region of France.

Reports are coming in from various observers, and show that the display was quite up to, if it did not exceed, the average. Mr. D. E. Packer, writing from Birmingham, says:—"On Saturday night, August 10, several hundreds of meteors were observed here in a four-hours' watch, commencing at 10 p.m. On Sunday, August 11, during the same period of time the number nearly reached a thousand. At 11 p.m. a magnificent fireball burst over the southern part of the sky, lighting up the heavens with a full moon radiance and leaving a brilliant streak of light which persisted for some little time." A correspondent of the *Nottingham Daily Guardian* says:—"On August 10 we had a splendid display of the meteors. The night proved to be the brightest and clearest I ever remember to have seen, and at about 10 o'clock meteors in great numbers were to be seen flitting across the heavens from north-east to south-west. On Sunday night, August 11, the display was repeated with even greater brilliance and frequency and with more variation, the sky being again very clear."

These descriptions may possibly convey a somewhat exaggerated idea of the character of the shower this year, but they sufficiently prove that the event was a conspicuous one and well worth the attention given to it.

As observed at Bristol the radiant point was pretty definite, for an area of about 3 degrees would include very nearly all the tracks directed from it on August 10 and 11. With reference to the minor showers, there were a considerable number visible, though they were very feeble. A few degrees south of the head of Draco and at the point $269° + 47°$, there was a radiant of bright-trained, slow-moving meteors, while east of ζ Persei at $63° + 30°$ there was a radiant of very swift streak-leaving meteors. There were other well defined showers from $290° + 53°$, $312° + 13°$ and $333° + 72°$.

W. F. DENNING.

Mr. W. E. Rolston sends the following account of observations made by him:—

"I commenced my observations at Birmingham at 10.45 p.m. on the night of August 11 and continued them till 12.48 a.m. on the morning of August 12, when a bank of clouds rising from the N.E. stopped further observations. For this period, of 2 hours 3 minutes, I counted 143 meteors, which appeared to have their origin in the region of Perseus, and 17 others having various origins. During this time a very clear sky obtained, rendering short and faint trails easily visible. All the observations were visual, and, as I happened to have exhausted my stock of plates, I was unable to attempt the securing of "trail" photographs. Several of the Perseids were remarkable either for their brightness, or else for the length of time their trails were visible after the nucleus had either disappeared below my horizon—of surrounding houses—or had died away. Observations on these, including the times of their appearance, are given in the appended table.

"From the 143 observations made, I deduced that the radiant point of these meteors is situated about the point whose coordinates are:—Decl. 58° N., R.A. 2h. 35m.

G.M.T. of appearance. (h. m.)	Remarks.
11 7	Remarkable for a very bright nucleus, and a vivid trail which remained visible *for* 53–55 *seconds;* first appeared in the region of κ Andromedæ (alt. about 60°), and travelled between Aquila and Delphinus to about alt. 25°, when it disappeared behind a housetop. The trail had a bluish-white and shimmering appearance.
11 14	Appeared in region of δ Cassiopiæ; was very bright, and trail lasted for 7 seconds.
11 35	Appeared in region of δ Cygni and travelled through Lyra, leaving a bright trail which lasted for 9 seconds.
11 53	Appeared in region of α Persei and travelled towards Aries; was very short, but very bright; evidently the greater component of its motion was in the line of sight.
11 55	Appeared in region of 33 Cygni and travelled S.W. through Lyra; very bright, and left a bright trail which lasted about 8 seconds.
12 5	Very bright and short; left bright trail which was, as nearly as I could judge, exactly parallel to a line joining β and γ Arietis, and near to them.
12 10	Very bright, leaving a good trail from Cassiopeia, half way between β Pegasi and ε Cygni.
12 15	A very bright meteor which "occulted" α Andromedæ and then travelled in the direction of the group 59, 57 and 55 Pegasi.

"In addition to the above, I remarked one of the extra 17—not a Perseid—which at 11.27 appeared at about the middle of The Great Square and travelled right through the zenith, disappearing near Corona and leaving behind it a remarkable red shimmering trail which lasted for 4 or 5 seconds.

"The above times given for the duration of trails were obtained by counting seconds from judgment, not by a watch. The observations were made whilst lying on my back, so that nearly the whole of the sky above the available horizon was observed."

SAND WAVES IN TIDAL CURRENTS.[1]

THE sand waves dealt with in this paper are not the well-known "current mark," or ripple mark of rivers, but the larger sort, first scientifically described by Prof. Osborne Reynolds. These larger sand waves are the normal production of a swift current when adequately supplied with sand. The supposed condition of "uniform drift" (the current picking up as much sand as it drops, and therefore neither silting nor scouring) is really so unstable that, when the current becomes sufficiently swift to hold sand in eddying suspension, it passes almost suddenly into wave motion, uniform drift being replaced by alternate silt and scour, giving ridges and furrows of sand which travel down stream. The material of the ridges is constantly being picked up by the current from the weather slopes, and deposited upon the lee slopes. Some explanation of the process was given in NATURE (vol. lxiii. p. 623, April 25) in the abstract of another paper by the author;[2] this is further elaborated in the paper now before us, which contains also details of the observations and measurements carried out during the year 1900, which have not hitherto been published.

The amplitude of the tidal sand waves is obviously limited by the depth of water, and it follows that as the tide ebbs off sand-banks, it tends to obliterate the ridges, leaving the banks with the smoothed surface which is familiar. Sometimes pools are left below the general level of the smoothed surface (Fig. 1). These have a steep and a gentle side, the former the lee slope of one ridge, the latter the weather slope of the next ridge. They are, in fact, homologous with the pits, called Fuljes, in sandy deserts.

FIG. 1.—A chain of pools, Annat Sand, Montrose.

Where the conditions are such that the tide covers and leaves the banks gently, though running strongly when the water is deep upon them, the banks dry out with their wave surface almost perfectly preserved. The required conditions were found by the author in the tidal basins with narrow entrances at Barmouth and Aberdovey, North Wales, at Findhorn and Montrose, N.B., and at the Dun Sands, on the Severn (Fig. 2), which are protected from the tide until well submerged by a rocky shoal, which juts out from the left bank of the river.

The observed wave-length or distance from ridge to ridge varied from 3 feet 6 inches to 54 feet. The smallest of these measurements was unusual. From 12 to 24 feet wave-lengths were common. The steepest ridges had a wave-length 13·39 times as great as their height. In the model estuaries of Prof. Osborne Reynolds the wave-length was twelve times the amplitude.

FIG. 2.—Interpenetrating ridges on the Dun Sands.

Fig. 3 shows the orderly march of the ridges upon a portion of a sand-bank in the estuary of the Dovey, which the author pegged out for purposes of measurement with stakes driven into the sand to a depth of about 3 feet. There were five transverse rows of stakes 15 feet from row to row, and in each transverse row the distance from stake to stake was 20 feet. This permitted the exact measurement of the position of five wave-fronts along four sections. String stretched from stake to stake at the two sides of the plot served as datum lines and enabled amplitude and mean-sand-level to be taken with tolerable accuracy along two sections. Measurements were made once a day when the sands were dry. From June 2 to 5, 1900, the tides were diminishing after springs, and the average amplitude of the ridges diminished from 6″·34 to 3″·71 with no perceptible change of mean sand-level. The average wave-length in the same time only diminished from 14′ 3″·7 to 13′ 6″·6, and the regularity of the wave-lengths improved, thus:—

	Per cent. of mean L.
On June 1, av. diff. of successive Ls.	= 13·4
,, 2 ,, ,,	= 11·4
,, 3 ,, ,,	= 10·7
,, 4 ,, ,,	= 4·4
,, 5 ,, ,,	= 6·6

On June 5 the tidal current appeared to have fallen below some critical velocity, and suddenly to have lost control of the wave system. This is shown by the following table of the average advance of the ridges, which was:—

From June 1 to June 2 ...	38″·07
,, ,, 2 ,, ,, 3 ...	29″·75
,, ,, 3 ,, ,, 4 ...	30″·57
,, ,, 4 ,, ,, 5 ...	1″·4

During neap tides the sands of the plot were almost smooth, and such undulations as could be seen on the surface were irregular and ill-defined. During the subsequent increase of tides, however, the plot emerged one day all covered with sharply defined ridges, which grew daily in height, and also (by elimination of some of the ridges) in length. On June 15 the average amplitude was 9″·71, with an average wave-length of 11′ 9″. The increase of wave-length appears to take place by the obliteration of certain ridges which find themselves unfavourably placed owing to the too great growth of the ridge on

[1] Abstract of a paper by Dr. Vaughan Cornish, read before the Royal Geographical Society, June 10, and published in the *Geographical Journal*, August 1901.

[2] "On the Formation of Wave-surfaces in Sand," *Scottish Geographical Magazine*, vol. xvii., January 1901.

the weather side. Thus the increase of amplitude is a steady process, whereas the increase of the wave-length (if determined by measurement along one or two sections of a few ridges) takes place *per saltum*, or, as Dalton might have said, in "multiple proportion."

It is pointed out that the tidal sand ridges, by their size, orientation, and lateral extension, afford an admirable means of mapping the tidal currents in those estuaries in which circumstances secure their preservation on the sand-banks visible above low-water mark.

Between the date of the writing and the publication of this paper the author observed in Canada the formation of long trains of waves of snow, by a process similar to that which creates these sand waves. They are distinct altogether from the ripples of drifted granular snow, which were also observed.

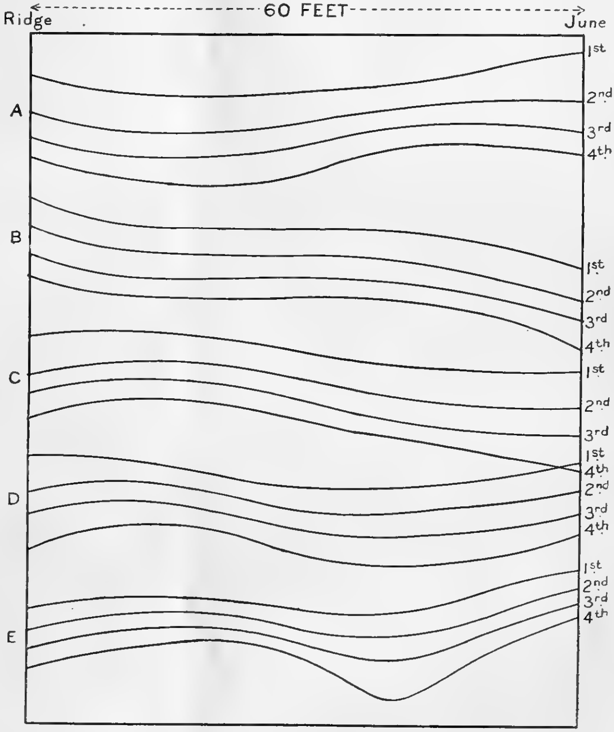

FIG. 3.—Plan of five sand ridges showing positions on four succeeding days, Dovey Estuary. Scale, 1 inch = 16 feet.

WOAD AS A BLUE DYE.[1]

MR. E. CORDER[2] has so thoroughly gone into the matter of East Anglian woad culture and preparation that the present remarks must be regarded as quite supplemental to his paper, having been, in fact, inspired by it. Frequent visits have been made to the Parson Drove Woad Mill, and a long series of experiments conducted before the blue colour, the indigo in fact, in this woad could be demonstrated. Curiously enough, the subject has engaged the attention of Prof. Beyerinck, of Delft, and by his help the presence of indigo was easily shown in the fresh plant from Parson Drove. The blue colour of woad is indigo—the same substance chemically as that obtained from *Indigofera tinctoria* and *Polygonum tinctoria*. There is this great difference however: in the last named plants it exists in a form which is easily extractable, whereas in woad it exists in a condition which is the very reverse.

In 1855, Dr. E. Schunck, in an exhaustive paper on the chemistry of woad, drew attention to the fact that indigo did not exist as ready formed indigo-white in this plant. He showed that the glucoside indican was the form from which indigo-white was produced by oxidation. In 1877, M. Alvarez attributed the formation of indigo to the action of bacteria, but in 1898 Bréaudat demonstrated that microbic life was not necessary.

Marchlewski and Radcliffe consider indican consists of sugar and a very unstable substance called indoxyl. Prof. M. W. Beyerinck holds the view that the indigo producing plants may be divided into two groups, in one of which this substance exists as indican (*Indigofera tinctoria* and *Polygonum tinctoria*), while in the other (of which woad, *Isatis tinctoria*, is the type) it exists as indoxyl. More recently, however, Beyerinck has come to the conclusion that even indoxyl does not exist ready formed in woad, but that it exists as a "loose compound" isatan, which by an enzyme isatase also present in woad is easily decomposed into indoxyl.

Be this as it may, it is not difficult to extract indigo blue from fresh woad leaves by the process given by Beyerinck. This consists in packing fresh woad leaves into a stoppered bottle and filling the bottle entirely with boiling water, inserting the stopper so that no air-bubble is left between it and the top of the water; after a few hours the infusion will be found of a pale yellow colour, having, when cold, a green fluorescence. If an alkali be added to this infusion and air blown through it, indigo blue is precipitated on the further addition of an acid. Woollen articles dipped into this alkalised infusion become, on exposure to the atmosphere, a pale azure blue. This change, however, takes place far more rapidly if they be dipped into acidulated water. The indigo thus obtained is, however, very apt to contain impurities; notably, to pass into a condition known as indigo-brown, in which an insoluble black-brown substance is formed which is useless to the dyer and cannot be reconverted into indigo blue. During the unsettled state of Europe towards the end of the eighteenth and beginning of the nineteenth century, numerous attempts were made to manufacture indigo directly from woad; prizes were offered by various Governments for the attainment of this object in order that the use of foreign indigo might be obviated, as it could only be obtained with difficulty. None of these processes were ever practically successful. Many of them were entirely theoretical. Some sought to obtain indigo by macerating fresh woad leaves in cold water, others in warm water, others by infusing them in boiling water and subsequently washing with cold.

To demonstrate the presence of indigo in the woad leaf, the process of Dr. Hans Molisch is the best. This consists in keeping the fresh leaves in a wide-mouth stoppered bottle, filled with gaseous ammonia for twenty-four hours, and then dissolving out the chlorophyll by immersing the leaves for a like period in absolute alcohol. Sections show that the indigo is confined to those tissues which contain chlorophyll, and that the hairs,

[1] Abridged from a paper by Dr. C. B. Plowright, in the *Transactions* of the Norfolk and Norwich Naturalists' Society, vol. vii. 1900–1901.

[2] Corder, E. *Trans.* Norfolk and Norwich Nat. Soc., 1890, vol. v. p. 144.

cuticular cells (excepting the guard cells of the stomata) and fibro-vascular bundles are free from it. When the chlorophyll has been thus extracted, the leaves have a blue colour of greater or less depth according to the amount of indigo they contain.

Although the extraction of indigo is so difficult and unsatisfactory a process, yet woad has been used as a blue dye from remote antiquity. Pliny refers to it as having been used to stain chalk blue for the adulteration of indigo, which was then a pigment of great rarity, as it had to be imported by the "overland route" from India.

The first printed reference to woad as a blue dye occurs in Ruellius ("De Natura Stirpium," 1536), who remarks in words of which the following is a translation :—"They crush the green plant in mills, so as to expel the vegetable juices, then when the moisture has been removed they make the woad up into large balls, and these they allow to lie on the floor and decay till they fall into ashes (dust). In many places they call woad 'pastel,' from the loaf-like shape into which the woad balls are made up. They heat (the dust of) these balls in vats, in dyers' shops and dip woollen cloths and skins therein, that they may absorb the blue colour. The blue scum floating on the surface, which the vats throw up when warming on the fire, our dyers call indigo; this they dry for the use of painters."

In 1555 Crolach published his small book on woad and its culture and preparation, from which it appears that Thuringia, one of the great woad producing districts of Europe, was already beginning to feel the effect of the introduction of indigo into Western Europe by the Cape route. A century later this was more pronounced, judging from what Wedelius says. His account of the woad industry is very good; so much so that Ray, the first professor of botany at Cambridge, copies it almost verbatim with due acknowledgment, which in its turn was copied and translated by the author of the English edition of Tournefort's "Herbal." The latter tells us, "the ground, which is plow'd in *Autumn*, must be left all *Winter* to be soak'd by the rain, till *the Purification of Our Lady*. After *Lady Day*, when the air is somewhat softer and milder, it is proper to sow it, and your end will be better answer'd if you sprinkle a little snow over it, and take care that you do not sow it too thick . . . . and after *Whitsuntide* you must weed all other herbs from it. After *St. John's Day* in the Beginning of Harvest it is ripe." It is interesting to add that the wadmen of the present day say that, "no wad should be gathered after Martimas Day" (November 15). Wedelius was essentially a chemist, and the main object of his book was to show that ammonia was produced from plants. He showed that ammonia was given off in large quantities during the couching of woad, and he also argued on theoretical grounds that woad contained sulphur, in both of which assertions he was correct. He tells us, as early as 1577 a decree was made at Frankfort to prevent the fraudulent and injurious substitution of indigo for woad, and on April 21, 1654, at Ratisbon, an edict was promulgated inflicting the penalty of confiscation against the further importation of indigo. The days of woad as a dye were, however, rapidly drawing to an end, and yet, paradoxical as it may seem, the dyers of the "greater dye" could not do without it. At this time no other equally good method was known by which indigo could be dissolved and used for dyeing. We find woad culture an important industry during the seventeenth and eighteenth centuries; accounts are to be found in the contemporary agricultural writers—Ellis, Trowell, Miller and Young. It was mostly carried on by itinerant "wadmen," who, with their families, travelled from place to place, growing the woad on newly broken up pasture land for which very high rents were paid. These gangs built their huts and wad mills with the sods from off the land, and were brought up to the industry from their childhood. They seldom stayed more than two or three seasons in the same spot, moving to a fresh location as soon as the soil became exhausted. Abroad Schreber's monograph, published in 1752, gives a very complete account, not only of the culture, but of the history of the subject, as well as copious extracts from the more important writers on the subject, with copies of the various proclamations, edicts, &c. In the appendix to this volume a German translation is given from Hellot's chapter on dyeing wool with indigo and woad. This book (Hellot's) was subsequently translated into English, anonymously. Under the "greater dye" or dyeing "colours in grain," it gives the *modus operandi* of working a woad or pastel vat, which was the best then known way of dyeing with indigo. The directions are sufficiently quaint; for instance, the writer begins by saying, "Your copper cauldron should be placed as near as possible to the vat and then filled with pond water: if the water be not sufficiently putrid you put in a handful of hay. When the copper is full the fire should be lighted under it at three o'clock in the morning." Then again, for every ball of pastel you throw in a full measure of *ware* (slaked lime), and sundry mysterious stirrings and coverings are enjoined, until the vat has "come to." When the indigo is put into it, there follow more stirrings and additions of ware, until the vat is ready for the "overture," or first piece of stuff to be dyed. "Towards the latter end of the week you dye the light blues, and on Saturday night, in order to preserve it 'till Monday, you *garnish* with a little more ware than on the day preceding." On Monday morning the vat was reheated, fresh indigo added to replace that which had been taken out by articles dyed during the preceding week, while bran and lime were added in the proper proportions. In point of fact a woad vat, once started, was kept going for many weeks or months, adding the indigo from time to time as required, as well as the requisite proportion of bran (sharps) and slaked lime (ware). The whole process was an exceedingly delicate one; if the lime was deficient the vat became putrid, if used too freely the vat "got the kick" and did not work at all; this was also the case if the proper temperature was not maintained.

What really takes place in a woad vat is concisely this :—Indigo blue is a very insoluble substance; it will not dissolve in any of the ordinary solvents, such as hot or cold water, dilute acids, alkalies, alcohol, ether, chloroform, &c. Hence it is a very fast dye if it can only be made to attach itself to a fabric. In order that this may be done, it is necessary to dissolve it; but, as we have seen, none of the ordinary solvents will do this. In the woad vat the chemical composition of the insoluble indigo-blue is altered; it is, as chemists say, reduced to indigo-white; now indigo-white is soluble in weak alkaline solution, hence the use of the slaked lime. If a skein of wool be dipped into a vat containing indigo-white in this state, the solution soaks into the tissues of the wool fibres; when the wool is taken out and exposed to the air, the oxygen unites with the reduced indigo and the skein passes from a greenish-yellow to a deep blue, the insoluble indigo-blue being thus formed and the fabric dyed in such a way that no mordant is required. The chemical changes which take place in the woad vat when once started are, that the starch of the bran is converted into grape sugar, which becomes lactic acid. The lactic acid becomes butyric acid, and in so doing nascent hydrogen is liberated, which reduces the indigo to indigo-white. Indigo is soluble in strong sulphuric acid, and there are other processes by which it can be reduced; but the above is the rationale of the woad vat, which has held its own from the time when the mediæval dyers added a little indigo to the vat to improve the colour of the blue down to this present time. It is an expensive, awkward and difficult process, but it has this one advantage—the colour produced is extremely durable. In actual practice a little madder is added; this is done, the dyers say, "to kill the green" in the indigo.

Woad was used long before indigo came into Europe, not as a solvent, but as a dye *per se*. Woad contains no indigo ready formed; not the slightest trace of any blue colour can be detected in it. With water it forms a dark brown mixture, which colours woollen fabrics olive-green. In order to dye with woad, all that is necessary is to pour boiling water on the woad and keep it in a well-covered vessel for fifteen or twenty hours at a temperature of about 110° to 140° F., not going above 150° or letting it fall below 100°. In about thirteen to fourteen hours bubbles of gas begin to rise; a very small quantity of slaked lime should now be added, and in a few hours woollen articles allowed to remain in it for an hour or two change from yellow to blue as they are taken out and exposed to the air. When the vat is in full working order the liquid is of an olive-brown colour, on the surface of which darker veins appear which change their position, slowly moving, appearing and disappearing spontaneously. The froth which at this time gathers on the surface of the vat is blue from the indigo precipitated by contact with the atmosphere. This constitutes the *caeruleum spumam* Ruellius speaks of as being dried and sold to the painters. It was also the "flowers of the woad" which the dyers of Coventry were accused of skimming off the woad vats in which they dyed their customers' goods and added to those vats in which they dyed their own. It is interesting to notice that, if a skein of wool be suspended in a small experimental vat in good working order, it is the upper part of the skein nearest the surface which takes the deepest colour, and next to it, as one would have imagined, the lower part nearest the sediment at the bottom. This blue scum was the probable source, not only of the woad blue which Pliny speaks of as being used in his time to stain chalk with for the adulteration of indigo, but also of the "ancient Briton" pigment, of which we hear so much and know so little. Cæsar and Pomponious Mela speak of our ancestors staining their bodies blue; it is difficult to understand how they could dye their skin blue, but it is easy to see how they could have smeared themselves with woad-blue mixed with oil or grease. Herodian, however, throws a little more light on the subject when he tells us that "they mark their bodies with various figures of all kinds of animals, which is the reason they wear no clothes, for fear of hiding these figures." The use of indigo for tattooing is still common among our soldiers and sailors.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. J. T. JENKINS has been appointed lecturer in biology and geology at the Hartley College, Southampton, and Mr. J. D. Coates assistant lecturer in physics and electrical engineering.

MISS ELEANOR ORMEROD, the well-known authority on agricultural entomology, lately deceased, bequeathed the sum of 5000*l*. to the University of Edinburgh. Miss Ormerod was an examiner in entomology for the University, and received from them last year the degree of LL.D.

THE councils of English Counties and County Boroughs expend upon scholarships a large amount of the money available for technical education. A report upon the scholarship schemes adopted by local authorities appears in the *Record* of Technical and Secondary Education, and it shows what is being done to provide continuous and systematic courses of training for promising students. It appears from this report that, taking County and County Borough Councils together, there are now 93 out of 110 such local authorities who provide scholarships in one form or another. The total number and value of the scholarships and exhibitions in force (*i.e.* those awarded and those continued and renewed from previous years) under the schemes of 90 of those 93 authorities during the year 1899–1900 were 19,971 and 156,793*l*. respectively. The scholarships are tenable at institutions of various ranks, and the number and value of those awarded annually in each class are as follows:—(1) At evening classes, 6766 (7862*l*.); (2) at technical and science and art schools, 3426 (17,064*l*.); (3) at secondary schools, 5593 (77,349*l*.); (4) at higher institutions and Universities, 679 (27,097*l*.); (5) at agricultural and horticultural schools, &c., 532 (9866*l*.); (6) at domestic science schools, &c., 1349 (12,199*l*.); (7) for elementary teachers, 1626 (5356*l*.). A comparison of these figures with similar returns obtained five years ago shows that a considerable increase has taken place in the number of scholarships tenable at permanent technical schools.

SCIENTIFIC SERIAL.

American Journal of Science, August.—Experiments on high electrical resistances, by O. N. Rood. The units of resistance employed were prepared by painting peroxide of manganese on strips of blue cobalt glass, then drying and immersing in a rosin wax bath at 150° C. It was found that the surface conduction of units prepared in this way in ordinary weather was practically zero. The aluminium leaf electrometer used in the measurements is also described. It was found possible to build up a set of high resistances with values from 32,000 to 14,000,000 megohms.—Mineralogical notes, by A. J. Moses. A description of mercuric iodide from New South Wales, some new forms on Bergen Hill pectolite and on atacamite crystals from Chili, realgar crystals from Snohomish County, Washington, vesuvianite from New Mexico, chrysoberyl from New York City, and a pyroxene crystal from the copper mines of Ducktown, Tenn.—On the motion of compressible fluids, by J. W. Davis.—The action of sodium thiosulphate on solutions of metallic salts at high temperatures and pressures, by J. T. Norton, jun. Solutions of various salts which are incompletely precipitated by sodium thiosulphate at the ordinary temperature were heated under pressure in sealed tubes at 120°–140° C. In many cases the reaction became complete, the whole of the metal being precipitated as sulphide or hydroxide. In a few cases the reaction was indeterminate.—Secondary undulations shown by recording tide gauges, by A. W. Duff.—Mathematical notes to rival theories of cosmogony, by O. Fisher.—Studies of Eocene Mammalia in the Marsh collection, Peabody Museum, by J. K. Wortman.—The electromagnetic effects of moving charged spheres, by E. P. Adams. The deflection of a magnetic needle caused by the rotation of two electrically charged spheres was measured, and in opposition to the views recently published by Cremieu, the deflections observed agreed with those calculated theoretically within the limits of experimental error.—The nadir of temperature and allied problems, by J. Dewar.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 20.—On the Behaviour of Oxy-hæmoglobin, Carbonic-oxide-hæmoglobin, Methæmoglobin and certain of their Derivatives, in the Magnetic Field, with a Preliminary Note on the Electrolysis of the Hæmoglobin Compounds, by Arthur Gamgee, M.D., F.R.S., Emeritus Professor of Physiology in the Owens College, Victoria University.

The following are the conclusions to which the author has been led by his experiments:—

(1) The blood-colouring matter, oxy-hæmoglobin, as well as carbonic-oxide hæmoglobin and methæmoglobin, are decidedly diamagnetic bodies.

(2) The iron-containing derivatives hæmatin and acethæmin are powerfully magnetic bodies. The differences in magnetic behaviour between the blood-colouring matter and acethæmin and hæmatin point to the profound transformation which occurs in the hæmoglobin molecule when it is decomposed in the presence of oxygen.

(3) The preliminary study of the electrolysis of oxy-hæmoglobin and CO-hæmoglobin renders it probable that, in the blood-colouring matter, the iron-containing group, on which its physiological properties depend, is (or is contained in) an electro-negative radical; according to analogy, the iron in such a compound would possess diamagnetic and not magnetic properties.

PARIS.

Academy of Sciences, August 12.—M. Fouqué in the chair.—A criterion for the recognition of singular points of the uniform branch of any monogenous function, by M. G. Mittag-Leffler.—On the infinitely small deformation of an elastic ellipsoid submitted to known forces on its boundaries, by MM. Eugène and François Cosserat.—Verification of the relation which exists between the characteristic angle of deformation of metals and the coefficient of restitution of their elasticity, by M. G. Gravaris.—On the colour of the ions, by M. G. Vaillant. The theory of ions applied to the coloration of solutions leads to the following consequences: in completely dissociated solutions containing only one coloured ion, the coloration is independent of the nature of the other ion; if the ionisation is incomplete, the coloration should vary with the concentration and nature of the non-coloured ion; and, finally, the coloration of a solution of any concentration ought to be related to its degree of dissociation by a formula with two moduli, and two only. All these conclusions were confirmed experimentally by a study of solutions of the permanganates of potassium, barium and zinc.—On the value of the molecular heats at the boiling point, by M. de Forcrand.—The action of benzoyl chloride upon trioxymethylene in presence of zinc chloride, by M. Marcel-Descudé.—A method for the prevention of hail, by

M. G. M. Stanoiéwitch. The use of a small captive balloon fitted with a deep-toned electrically-driven bell or siren is suggested as a means of breaking up hail clouds.

NEW SOUTH WALES.

Royal Society, June 5.—Mr. G. H. Knibbs in the chair.—On a new rock allied to nepheline phonolite, from Kosciusko, New South Wales, by F. B. Guthrie, Prof. David, F.R.S., and W. G. Woolnough. The Kosciusko rock is characterised by its large proportion of nepheline which dominates all the other minerals. The nepheline occurs in micro-porphyritic idiomorphic crystals. The soda-augite ægirine is also abundant, and there is a small amount of glassy material in the base through which are scattered delicate acicular crystals and microlites of felspar. A few small amygdules may be noticed, not sharply marked off from the surrounding rock; they consist of a shell formed chiefly of analcime enclosing secondary calcite. The specific gravity of the rock varies from 2·43–2·5. The rock differs conspicuously from typical phonolites in the following respects:—(1) low silica percentage; (2) entire absence of phenocrysts of sanidine. It is a felspathoid rock, and although its silica percentage allies it with the basalts, its mineral constitution, chemical composition and low specific gravity link it with the phonolites. So far as the authors are aware, it is unlike any rock that has hitherto been described from any part of the world.—Preliminary notes on the intermediary host of *Filaria immitis*, Leidy, by Mr. Thos. L. Bancroft. *Filaria immitis*, a worm-parasite of the dog, common throughout the world, but more especially in the warmer parts, of from five to ten inches in length, the males being the smaller, is found generally in the right ventricle of the heart and in the pulmonary artery. The so-called embryos, 1/90 in. × 1/3500 in., are produced in great numbers; the late Dr. Spencer Cobbold taught that an intermediary host was necessary to transmit the parasite from one dog to another. Among others, Grassi, Sonsino and J. Bancroft endeavoured to discover this intermediary host. The dog-flea (*Pulex serraticeps*), the various dog lice, and ticks were examined, but with negative results. The author for thirteen years past had endeavoured to find the intermediary host, examining *Pulex serraticeps;* the common horse-fly, *Stomoxys sp.?; Culex vigilax*, Skuse—a day-flying mosquito; the intestinal worm parasite of the dog—the *Anchylostoma* or *Dochmius trigonocephalus.* The possibility of metamorphosis being essential seemed doubtful, the embryo might, it was thought, go through a cold stage for several days in the body of an insect and then develop, after introduction into the body of the dog. A puppy, who ate 110 *Stomoxys* flies gorged with filariated blood, in one month showed after a series of experiments, extending over nearly a year, that such an hypothesis was untenable; and moreover, that the time taken by the young filaria to arrive at sexual maturity was not less than seven months nor more than twelve. After discussing Grassi's discovery of the intermediary host of *Filaria immitis*, viz. the *Anopheles maculipennis*, Meigen, syn. *A. claviger*, Fab., and the statements of a paper by Grassi and Noè on "the propagation of the filariæ of the blood exclusively by means of the puncture of peculiar mosquitoes," the author states we are now able to give an exact account of the life-history of both *Filaria nocturna* and *F. immitis.* The sexually mature worms in man or dog produce embryos, which swim in the blood: the mosquito on biting abstracts some of the embryos, these develop in the mosquito's body, and in about three weeks are capable of entering their final or definite hosts, passing into the puncture made by the mosquito in the skin; they then advance to sexual maturity in the course of about a year. The position in the mosquito's body during the metamorphosis of the embryos distinguishes *F. nocturna* from *F. immitis*, the former being in the thoracic muscles, the latter in the malpighian tubes, at their maximum development; the latter are distinguished as being shorter and thicker. It has been learnt that mosquitoes live for long periods, and not merely a few days as was formerly supposed, and that during their life they bite frequently. In Europe, *Anopheles maculipennis* plays the *rôle* of host for the malarial parasite, for *F. immitis* and it is believed also for *F. nocturna;* in Australia the house-mosquito, *Culex skusii*, Giles, is host for both *F. nocturna* and *F. immitis*, and probably also for the malarial parasite.

Linnean Society, June 26.—Mr. J. H. Maiden, president, in the chair.—On the occurrence of diatoms and radiolaria in the Rolling Downs Formation (Lower Cretaceous) of Queensland, by Prof. David, F.R.S., W. S. Dun and W. H. Rands.—Notes on an aboriginal grave in the Darling River District, N.S.W., by Graham Officer. Certain objects of aboriginal manufacture found over a large area of the western division of New South Wales have hitherto been somewhat of a puzzle to anthropologists, and precise information about them is very difficult to obtain. The objects in question are of two types, one of which has already received consideration from Mr. W. R. Harper in the Society's *Proceedings* for 1898 (p. 420). A second type is described in the present paper, some examples of which were found on an aboriginal grave arranged in a circle about three feet in diameter. The author concludes that the objects of both types had a phallic significance; also that those of the first type were used to mark the graves of men, while those of the second type were placed on the graves of women, possibly also of youths who had not attained their tribal majority.—The "shot-hole" fungi of stone-fruit trees in Australia, by D. McAlpine. The shot-hole effects produced in stone-fruit trees are shown to be due to an effort on the part of the tree to get rid of a parasite or other irritating agent, and the formation of a callus bounding the spot is a special property of the living tissue. At least twenty fungi are known at present to be the cause of "shot-hole," and of these one-half are found in Australia.—Australian Psyllidæ, part ii., by W. W. Froggatt. Twenty-four species referable to three subfamilies are described as new.—On the "onvar" of Malekula, New Hebrides, by Walter R. Harper. The "onvar" or thumb-guard of the Malekulan archer was first mentioned by Captain Cook, and a decorated form of it—probably part of the insignia of a chief—was described by Forster. The more common form is a circular piece of hard though light wood about 3 cm. in thickness, 12 cm. outside diameter at the base, bevelled off to an outside diameter of 7 cm. at the top and pierced by a hole large enough to admit the hand of the wearer, the average diameter of the opening in five specimens being 6·5 cm.

CONTENTS.

THURSDAY, AUGUST 29, 1901.

THE HISTORY OF PHYSIOLOGY.

Lectures on the History of Physiology during the Sixteenth, Seventeenth and Eighteenth Centuries. By Sir M. Foster, K.C.B., M.P., M.D., D.C.L., Sec. R.S., Professor of Physiology in the University of Cambridge. Pp. 310. (Cambridge: University Press.)

THERE is no more fascinating chapter in the history of science than that which deals which physiology, but a concise and at the same time compendious account of the early history of the subject has never before been presented to the English reader. Physiologists therefore owe a debt of gratitude to Sir Michael Foster for supplying a want which was widely felt. The following is a short account of the contents of the book, to which no higher praise can be given than to say that it is worthy of the reputation of its author.

As already remarked, the subject itself is a fascinating one, and it is rendered the more so by the manner in which it is treated in these lectures,[1] which abound with interesting biographical details and with quotations from the works of the early masters of science. The work is one which will interest circles far wider than physiological, for so intimately are the natural sciences interconnected that it is impossible to write the history of any one without constantly referring to points in the history of others. This must especially be so with physiology, which is directly based upon anatomy, physics and chemistry. It is not therefore surprising to find that the first lecture is devoted to the work of Vesalius and the early history of anatomy.

Andreas Vesalius was born in Brussels on December 31, 1514; his father was apothecary to the Emperor Charles V., and his mother, "to judge by her maiden name, Isabella Crabbe, was probably of English extraction." He studied at Louvain and at Paris, in the latter place under Jacobus Sylvius and Guinterius. That was a time when neither anatomy nor medicine was recognised outside the pages of Galen: if the facts were not reconcilable with Galen, so much the worse for the facts; it was rank heresy to teach otherwise. But Vesalius early determined to investigate for himself, and, although he had to resort for his material to the graveyard and even to the gibbet, where, he says, "'to the great convenience of the studious, the bodies of those condemned to death were exposed to public view,'" he was not to be deterred from his purpose. At the age of twenty-one he migrated to Venice, and was almost immediately appointed to teach surgery and anatomy at the University of Padua. Here his opportunities for study were far greater than in Paris or Louvain, and after five years' patient labour he produced his great work "On the Structure of the Human Body," which was published at Basel in 1543. "This book," says Foster, "is the beginning, not only of modern anatomy, but of modern physiology."

It is true that Vesalius dealt but little with physiology, being for the most part content to teach the Galenic doctrines, he himself saying that "'he accommodated his statements to the dogmas of Galen, not because he thought that these were in all cases consonant with truth, but because in such a new great work he hesitated to lay down his own opinions, and did not dare to swerve a nail's breadth from the doctrines of the Prince of Medicine.'"

But he no doubt recognised that the new truths about anatomy which he was promulgating involved the modification or rejection of the old dogmas. And it is certain that the publication of his work was so received, for the storm of opposition which it raised from the orthodox teachers of the time proved sufficient to terminate Vesalius' career as an anatomist. In disgust he burnt all his manuscripts, and accepted the post of Court Physician to Charles V. This was in 1544, and, although he lived some twenty years longer and was able to see his work beginning to bear fruit, he himself produced no more.

While it is clear that Vesalius did not really believe that the blood passed from the right heart to the left through the septum, as Galen supposed, it was Servetus, the Unitarian physician who was burnt at the stake by Calvin, who, in a theological work written in 1546 and published in 1553, first clearly enunciated the opinion that the communication occurs through the lungs. But how far this opinion was the result of experiment and observation and how far it was mere conjecture is difficult to say; in any case Servetus' suggestion had little influence upon the progress of physiology, nor was it accepted until, in the course of the following century, the proofs were furnished by Harvey. Like all great discoveries, that of Harvey was led up to by the work of previous observers, more than one of whom arrived very near the truth. This is the case, as we have seen, with Servetus so far as the pulmonary circulation is concerned, with Cæsalpinus, and with Realdus Columbus (who is, however, supposed to have "cribbed" from a manuscript of Servetus). Fabricius of Aquapendente, Harvey's master, supplied in his discovery of the valves of the veins one of the most important facts upon which Harvey's doctrine of the circulation was based. But there can be no difference of opinion as to the fact that the history of physiology itself and all advance in surgery and medicine begins with Harvey, for until the action of the heart and the circulation of the blood were understood there could be no correct understanding of the working of any part of the animal mechanism. To this subject the second lecture is accordingly devoted.

Harvey was born in 1578 at Folkestone. He took his degree at Cambridge in 1597, studied four years under Fabricius at Padua, became physician to St. Bartholomew's Hospital in 1609, and "ventured in 1615 to develope, in his 'Lectures on Anatomy' at the College of Physicians, the view which he was forming concerning the movements of the heart and of the blood. But his book, his *Exercitatio*, did not see the light until 1628." He was physician to Charles I., after whose death "he retired into private life, publishing in 1651 his treatise, *De generatione animalium*, . . . and on June 3, 1667, he ended a life remarkable for its effects rather than for its events."

"His wonderful book, or rather tract, for it is little more, is one sustained and condensed argument." Up

[1] The lectures were delivered as the "Lane Lectures" at the Cooper Medical College in San Francisco in the autumn of 1900.

to the time of Harvey it was supposed, and was commonly taught, that the heart acted like a suction pump, not like a force pump; that the diastole was the active, the systole the passive, condition; that the blood ebbed and flowed in the veins and arteries; that air and vital spirits passed to the heart by the pulmonary arteries; that the blood, or part of the blood, passed from the right ventricle to the left through pores in the septum. Harvey's results were arrived at partly by anatomical observation and inference, but chiefly by physiological observation and experiment. His arguments were founded,

"not on general principles and analogies, but on the results of 'frequent appeals to vivisection.' 'When first I gave my mind to vivisection, as a means of discovering the motions and uses of the heart, and sought to discover these from actual inspection, and not from the writings of others, I found the task so truly arduous, that I was almost tempted to think, with Frascatorius' (a Veronese doctor of the sixteenth century and more a poet than a man of science), 'that the movement of the heart was only to be comprehended by God. For I could neither rightly perceive at first when the systole and when the diastole took place, nor when and where dilatation and contraction occurred, by reason of the rapidity of the movement, which in many animals is accomplished in the twinkling of an eye, coming and going like a flash of lightning.' But the patient and prolonged study of the heart in many animals showed him that 'the motion of the heart consists in a certain universal tension, both of contraction in the line of its fibres and constriction in every sense, that when the heart contracts it is emptied, that the motion which is in general regarded as the diastole of the heart is in truth its systole,' that the active phase of the heart is not that which sucks blood in but that which drives blood out."

In this way Harvey came to see clearly, what had been already dimly guessed at by more than one of his forerunners, that the right heart receives blood from the venæ cavæ and pumps it through the lungs into the left heart. From it there followed

"another conception, which, however, 'was so new, was of so novel and unheard of a character, that in putting it forward he not only feared injury to himself from the enmity of a few, but trembled lest he might have mankind at large for his enemies.' . . . To this new view he was guided by distinctly quantitative considerations. . . . This is what he says: 'I frequently and seriously bethought me, and long revolved in my mind, what might be the quantity of blood which was transmitted, in how short a time its passage might be effected, and the like; and not finding it possible that this could be supplied by the juices of the ingested aliment without the veins on the one hand being drained, and the arteries on the other hand becoming ruptured through the excessive charge of blood, unless the blood should somehow find its way from the arteries into the veins, and so return to the right side of the heart; I began to think whether there might not be *a motion, as it were, in a circle*. Now this I afterwards found to be true. . . .' To that true view of the motion of blood he was led by a series of steps, each in turn based on observations made on the heart as seen in the living animal."

His argument is essentially a physical mechanical argument, and his demonstration was the "deathblow to the doctrine of the distribution of 'animal spirits' by the blood," although he does not himself deal with that doctrine and only refers to it incidentally.

The revival of the study of physics under Galileo and his pupils in the seventeenth century had a marked influence upon the progress of the new physiology, and forms the subject-matter of the third lecture. In particular Borelli (1608–1679), the famous professor of mathematics at Pisa, influenced largely by his friendship with Malpighi, set to work to apply physical laws to physiological problems. His great work, "De motu animalium," was not published until just after his death, but what is printed in it had been taught publicly long before, and much of the work had long been in manuscript.

A large part of Borelli's work is devoted to the special mechanical problems. He treats in succession of muscular mechanics, of standing, walking, running and locomotion in general, and investigates them by the aid of mathematics (his discussions concerning these problems may still be read with profit); he even attempts to solve the nature of muscular motion by mechanical methods. He estimates the force of muscles and of the heart, shows how the elasticity of the arteries aids the flow of blood through them, deals with the mechanics of respiration, and anticipates the modern attempts to account for all the phenomena of secretion by a mechanical explanation. Even nervous phenomena are explained by him as due to oscillations transmitted by a fluid, and in the same spirit he discusses "the generation and nutrition of both plants and animals, and even the nature of several diseases. . . . He was so successful in his mechanical solutions of physiological problems that many coming after him readily rushed to the conclusion that all such problems could be solved by the same methods."

The work of Marcello Malpighi (1628–1694), the friend of Borelli, and his colleague at Pisa during three years, although the greater part of his life was spent at Bologna (his native city), is dealt with at great length in the fourth lecture of the series. With his character the lecturer has obviously the fullest sympathy.

"Kindly even to softness, ready to give his affections to those who seemed drawn to him, devoted wholly to those who had won his love, modest and retiring even to timidity, bold only in the interests of truth and right, never in his own . . . beloved for the sake of himself, even by those who were not competent judges of his talents and his works."

Four years of his life, viz. from 1662–1666, Malpighi spent at Messina, as professor of medicine, and it was here that he began those researches into the minute anatomy of fishes and invertebrates which "opened up in his mind views as to the real nature of the like but more complex structures of man and the higher animals."

Malpighi's relations to the young Royal Society of London are well known. These relations began in 1667 and continued throughout his life, and the Society "had the honour of publishing and of bearing the expense of publication of the greater part of Malpighi's works." His work was essentially founded upon the use of the microscope, which had but recently been invented, or rather improved and rendered an instrument available for research. He and Nehemiah Grew, independently and almost simultaneously, laid the foundations of our knowledge of the structure of plants. He may also be regarded as the founder of embryology, for he gave the first adequate description of the changes undergone by the developing chick *in ovo*. He described the capillary circulation, and thus completed the immortal discovery of Harvey, and although not the first to observe the corpuscles of the blood, for he was anticipated in this by a few years by Swammerdam, his observation was independent of Swammerdam's, and made long prior to its publication. The extent of his researches into the structure of the tissues and organs is testified to by the number of parts to which his name is attached, *e.g.* the Malpighian tubules of insects, the rete Malpighii of the epidermis, the Malpighian bodies of the spleen and kidney. "Whatever part of natural knowledge he touched he left his mark; he found paths crooked and he left them straight; he found darkness and he left light."

The effect upon physiology of the new knowledge of chemistry which was dawning in the seventeenth century, as the result, in large measure, of the work of van Helmont (1577–1644), mystic though he was in many matters, and of his immediate successors, is dealt with in the fifth and sixth lectures. Practising as a physician, van Helmont was nevertheless mainly occupied, at Vilvorde in Belgium, with carrying out chemical observations and experiments. Although he received the Elijah cloak of Paracelsus, whose spiritualistic doctrines he adopts and even develops, and although he was still imbued with the Galenic doctrines, in spite of the fact that Harvey's work was already published when he wrote and must have been known to him, he nevertheless shows himself to be

"a patient, careful, exact observer . . . who watches, measures and weighs, who takes advantage of the aid of instruments of exact research, who reaches a conclusion by means of accurate quantitative estimations. . . . Throughout the whole of his writings is seen the continued endeavour to weave his exact chemical physical knowledge and his spiritualistic views into a consistent whole. . . . These two sides of van Helmont's character are not unfitly indicated by the two words *gas* and *blas*, 'two new terms,' he himself says, 'introduced by me because a knowledge of them (*i.e.* of the things they indicate) was hidden from the ancients.' By '*blas*' he meant an invisible spiritual agency which directs and governs material changes: this is the *archeus* of Paracelsus. By '*gas*' he clearly meant what we now call carbonic acid gas. . . . He gives it that name because the sound is not so far from that of 'chaos,' the unformed womb of all things."

He shows that gas is produced by the combustion of charcoal, by the fermentation of fruits, by the ignition of gunpowder. He gives an account of digestion, which he likens to fermentation. He recognises the essentially acid nature of the gastric secretion and its chemical action upon food. He describes absorption from the intestines as being due, in part at least, to diffusion. But he does not grasp the idea of the use of air in breathing; he still clings to the old notion of "vital spirits." He anticipates modern physiology in teaching that the tissues prepare their own substance independently from the blood. But, to judge by his writings, van Helmont was at heart more pleased with his blas than with his gas. "He allows to man alone a sensitive soul. The throne of this soul is in the pylorus; 'there it sits and there it abides all life long.' He gives reasons for this conclusion, *e.g.* a great emotion is felt at the pit of the stomach; a severe blow in the pit of the stomach will stop the heart."

Van Helmont was followed by Franciscus Sylvius (1614–1672) in explaining many of the phenomena of the body by the help of chemical science, and by Regner de Graaf (1641–1673) in his observations upon digestion. De Graaf was the first to obtain pancreatic juice, saliva, and bile from artificial fistulæ; his methods are used at the present day. And soon afterwards the knowledge of glands and their functions was still further advanced by the discoveries of Peyer (1653–1712), and von Brunner (1653–1727), of the glands in the intestine now known by their names.

But the progress of chemical science was destined to be arrested for many years by the speculations and teaching of George Ernest Stahl (1660–1734), who was successively court physician at Weimar, professor of medicine at Halle, and physician to the King of Prussia. "He was an accomplished chemist, and his name must always be borne in mind in dealing with the history of science, if for nothing else, for the reason that he was the author of the famous theory of phlogiston, which ruled with a rod of iron, as it were, the thoughts of natural philosophers for a hundred years."

Stahl maintained the view that the chemical changes of the living body were entirely different from those of the laboratory, that they were directly governed by the sensitive soul, which pervaded all parts, which not only set the chemical agent in motion, but was itself the agent. "He thus stands forth at the close of the seventeenth century as the founder of 'animism,'" a doctrine which, under the name of a vital principle, maintained itself through the succeeding centuries, and exists in a modified form even at the present day.

The seventh lecture of the series, which is devoted to the English school of the seventeenth century and deals mainly with the evolution of the physiology of respiration, is one of great interest, bound up as it is with the early history of the Royal Society. The fundamental experiment that a candle goes out, an animal dies, in a space deprived of air is due to Robert Boyle (1660). Robert Hook in 1667 showed the Fellows of the Royal Society that an animal can be kept alive by artificial respiration without any movement of the lung or chest wall; that the air alone, coming in contact with the blood, is the essential part of respiration. Richard Lower (1631–1690), besides his well-known work on transfusion and on the structure and action of the heart, also carried the subject of the physiology of respiration still further by showing that the change of the blood from venous to arterial is merely a change of colour due to air; he concluded that this entrance of fresh air into the blood is as necessary for the body as for the combustion of fuel. But it was left for John Mayow (1643–1679) to prove that it is a part only of the air to which this property is due, and to this part he gave the name of "nitro-aereal or igneo-aereal" spirit, which was neither more nor less than that which we now term oxygen. This was before Stahl had introduced the phlogiston theory, the essence of which was that when a combustible body was burned, phlogiston departed from it: it lost weight. Mayow is quite explicit on this point, showing that when antimonium is burned it increases considerably in weight. "'Now we can hardly conceive that the increase of weight of the antimonium arises from anything else than from the igneo-aereal particles inserted into it during the calcination.'"

Mayow fully identified burning and breathing. He found that either a lighted candle or an animal in an enclosed space exhausts a certain proportion of the air. "'We may infer,'" he says, "'that animals and fire deprive the air of particles of the same kind.'" "'It is clear,'" he adds elsewhere, "'that even the very plants seem to have some need of breathing, some need of drawing air into themselves.'" "In his tract, 'On Respiration,' he gives an exposition of the mechanics of breathing which might almost find its place in a text-book of the present day." He further supposed that the heat of the body is kept up by union of tiny nitro-aereal particles with salino-sulphureous (*i.e.* combustible) particles of the blood—a "sound theory," says Foster, "of animal heat," although now superseded, as will be subsequently seen, by one which places the union in the tissues themselves.

But the "great truth" which had been reached by the labours of these English physicists and physiologists died out with Mayow.

"The world had to wait for more than a hundred years till Mayow's thought arose again, as it were, from the grave in a new dress, and with a new name; and that which in the first years of the latter half of the seventeenth century as igneo-aereal particles shone out in a flash and then died away again in darkness, in the last years of the eighteenth century, as oxygen, lit a light which has burned, and which has lighted the world with increasing steadiness up to the present day."

The rise of the modern doctrines of combustion and respiration, the work of Black, Priestley and Lavoisier, is dealt with in the ninth lecture of the series, the eighth being devoted to the researches of Réaumur, Spallanzani, Stevens and John Hunter on gastric digestion. Although van Helmont had shown the stomach to be a great digestive organ and the acid character of its secretion its essential feature, subsequent authorities had ignored or denied its agency in digestion. It was regarded as having mainly a mechanical function. But Réaumur, who was eminent in other sciences besides physiology, showed clearly, by causing a kite to swallow small metal tubes closed at each end by a grating and filled with food, that without any trituration and with no semblance of putrefaction both meat and bone became dissolved whereas vegetable grains were little altered. He even obtained gastric juice from pieces of sponge included in the tubes, and found it to be acid. Spallanzani, who was born in 1729 and the centenary of whose death was celebrated two years ago, was successively professor of logic at Reggio and of natural history at Modena and at Pavia. He wrote on many subjects of natural history, but in physiology chiefly upon respiration and digestion—experimenting by Réaumur's methods upon all kinds of animals and even upon himself. He obtained gastric juice as Réaumur had done, but was successful in showing its activity *in vitro*, in which Réaumur had not succeeded; he failed, however, to detect its acid character. Similar experiments to those of Spallanzani were made independently by Stevens, of Edinburgh, who announced his results in an inaugural thesis in 1777, the same year as the publication of Spallanzani's first paper on the subject. Stevens also obtained "pure gastric fluid" from the stomach of a dog killed during fasting, and found that at the body temperature it readily dissolved meat, and he made besides numerous experiments by Réaumur's method on digestion *in vivo*. John Hunter, in 1772, "constantly found that there was an acid, though not a strong one," in the gastric juice, but later on he is led to regard this as not essential. The acidity which van Helmont had insisted upon at the beginning of the seventeenth century was not accepted until the nineteenth.

Stephen Hales (1677–1761) was a Fellow of Corpus Christi College, Cambridge, and became perpetual curate of Teddington in Middlesex. "He was devoted to science; he had begun to experiment while at Cambridge in the 'elaboratory' of Trinity College," where Bentley was then master; "and he continued his researches amid his parish duties at Teddington." He was the first to determine by experiment upon the living animal (horse) the pressure of the blood in the arteries, and he dealt also with the flow of sap in plants. "His writings contain the first clear enunciation of the existence of gases in a free and in a combined condition."

It is the merit of Joseph Black (1728–1799), who was professor of chemistry successively in Glasgow and Edinburgh, to have rediscovered the "gas" of van Helmont: to this he gave the name of "fixed air." He proved that it is given off in combustion, in fermentation and in respiration; that it is irrespirable; and he at first thought that it formed the irrespirable portion of the atmosphere. But Rutherford, of Edinburgh, in his inaugural thesis in 1772, showed that after the "fixed air" (caused by combustion) had been removed by caustic alkali, "a very large proportion of air remains which extinguishes life and flame in an instant." This was nothing else than the discovery of *nitrogen*, although its connection with nitre was first shown later by Cavendish.

Just as Black rediscovered the *gas sylvestre* of van Helmont, so Priestley (1733–1804) and Lavoisier (1743–1794) rediscovered the gas which Mayow had termed the igneo-aereal spirit and which was ultimately named by Lavoisier *oxygen*. Priestley was a Unitarian minister—"a man of letters as well as man of science, prolific theologian and ardent politician." He was the first to discover that the something in the air which is removed by the burning of a candle or by the respiration of an animal is restored by vegetation. He obtained from mercuric oxide (*mercurius calcinatus per se*), by heating it with a burning glass, a quantity of "air." "'Having got about three or four times as much as the bulk of my materials, I admitted water to it, and found that it was not imbibed by it. But what surprised me more than I can well express was that a candle burned in this air with a remarkably vigorous flame . . . and a piece of red-hot wood sparkled in it.'"

"He obtained the same gas from red precipitate and from minium; he found that a mouse lived well in it . . . that it was four or five times as good as common air."

Imbued with the phlogistic theory, he regarded it as common air which was freed from phlogiston, "dephlogisticated air," and he endeavoured to explain all his own results as well as the changes occurring in combustion and respiration on the same theory. Thus although in 1774 he prepared oxygen he did not discover it in the true sense of the word, because he failed to understand his discovery. This was reserved for Lavoisier, who, in the year following (1775), published his paper "On the nature of the principle which combines with metals during their calcination," in which he conclusively showed that the principle is taken up from the air, is part of the air. Two years later he demonstrated that the same substance "is the constructive principle of acidity," and he called it the acidifying (or oxygine) principle.

The composition of the atmosphere now became clear; the discovery, or rediscovery, of nitrogen (or *azote*, from its inability to support life) naturally followed, and the gaseous exchanges in the lungs between oxygen from the air and Black's "fixed air," or "aeriform calcic acid," as it was at first termed by Lavoisier, were demonstrated, as we at present understand them. "Thus at a single stroke did this clear-sighted inquirer solve the problem of oxidation, and almost, if not quite, the problem of respiration." This was in 1777.

Three years later Lavoisier and Laplace published their celebrated memoir on heat. In this they definitely state—as the result of measurements of the amount of heat produced by the combustion of a given weight of carbon when burned to carbonic acid, and the amount given out by an animal with the production of a given quantity of carbonic acid—that "respiration is a combustion, slow it is true, but otherwise perfectly similar to the combustion of charcoal. It takes place in the interior of the lung . . . The heat developed by this combustion is communicated to the blood . . . and is distributed over the whole animal system." Later Lavoisier recognised that the combustion of hydrogen, which had been discovered by Cavendish in 1781, takes a part in the production of animal heat. Not until long after Lavoisier—not, in fact, until well into the nineteenth century—was it recognised that the combination of oxygen with carbon and hydrogen occurs, not in the lungs, but in the tissues. Lavoisier was but fifty years old when he was swept away, in 1794, in the maelstrom of the Revolution; all too soon for the science which he had done so much, and in so short a time, to advance.

The tenth and final lecture is devoted to the older doctrines of the nervous system. The views of Vesalius and of Descartes (1596–1650), of Willis (1621–1675) and Glisson (1597–1677), of Borelli, of Stensen (1638–1686) and of Haller (1708–1777) are here set forth, and the history of the doctrine of "irritability" of tissues, first enunciated by Glisson and afterwards by Haller, is described. But, as a matter of fact, the physiology of the nervous system is almost entirely the product of the nineteenth century; before that it can scarcely be said to have a history; everything was obscure, and the place of facts was occupied for the most part by vague speculations.

One of the most prolific subjects of such speculation was the seat of the soul, which was assigned by van Helmont (as we have already seen) to the pit of the stomach, by Descartes to the pineal gland, by Haller, with better reason, to the medulla oblongata. "But we have learned much since Haller's time." . . . "And if he," adds Foster, "with the knowledge and the means at his command, seems to us to-day to have often gone astray, shall not we ourselves one hundred years hence still more often appear to have gone astray?" To which it may perhaps be replied that, although it will always be human to err, yet the means at our command are so much more complete and the methods so much more accurate that it is far less likely that we shall take a start in a wrong direction, or, having taken it, shall continue in it; in this at least we have an advantage over our eighteenth century predecessors, whose methods were, comparatively speaking, rough and their means and opportunities relatively limited.

Whilst endeavouring in the above account to give a general idea of the character of the book with which Sir Michael Foster has enriched the world of science, it is by no means an easy task to do adequate justice to the mine of literary and historic research which the author has laid open to view. But if a perusal of this account serves to induce others to go to the original, we can promise them that they will find it as interesting a story as may be met with for many a long day. And it is to be hoped that the perusal of Sir Michael Foster's history will stimulate the desire of its readers to make the direct acquaintance of the great authors who, during the three centuries under review, laid the foundations of modern physiology and, with it, of the sciences upon which modern physiology is based.

E. A. S.

FILTRATION OF WATER.

Water Filtration Works. By James H. Fuertes. Pp. xviii + 283. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1901.) Price 10*s*. 6*d*.

FILTRATION, which is generally regarded as an essential process in the provision of domestic water-supplies for large towns in England, especially when rivers constitute the source of supply, has been neglected to a considerable extent in the United States, and, therefore, the publication of a book, by an American engineer, dealing wholly with this subject, will be particularly valuable if it should lead municipalities in the United States to the more general adoption of this safeguard against the distribution of water to large populations in a condition dangerous to health. Polluted river waters, in their natural condition, have proved very fatal to our troops in South Africa, as shown by the high rate of mortality from enteric or typhoid fever; and the author, at the commencement of his book, draws a very striking contrast between the annual death-rate from typhoid fever per 100,000 persons in cities supplied with pure or filtered water, such as the Hague, Munich, Dresden, and Berlin, with a typhoid death-rate of only from 4·7 to 7, and Washington, Louisville, and Pittsburg, supplied with unfiltered river water, where the yearly typhoid death-rate for several years has averaged 71, 74, and 84, respectively, per hundred thousand of population. River waters are to some extent purified by natural agencies during their downward flow if no fresh causes of contamination are introduced, depending on the extent of their original pollution and the length of their uncontaminated flow; and the impurities in suspension may to a considerable extent be removed by causing the water to remain at rest in a settling basin for a certain period before distribution, so that the larger, heavier particles are deposited at the bottom of the basin. Generally, however, after this subsidence has taken place, the finer, lighter particles and micro-organisms remain in suspension in the water, as well as substances in solution; and the final purification can only be effected by filtration, assisted often by aëration, and sometimes by chemical processes.

After an introductory chapter and a chapter on intakes, sedimentation, and settling basins, the author proceeds to the consideration of his main subject, filtration. Two methods of filtration are described for the purification of water-supplies, namely slow sand-filtration, denoted as the English method, from its first introduction and general use in this country, and rapid sand-filtration, requiring the preliminary addition of a chemical solution, termed a coagulant, to render this rapid system efficient, which, being a distinctly American invention, is called the American method. Two chapters are devoted to the consideration of each of these methods in succession, the first in each case discussing the theory, efficiency, and influences of different arrangements and modifications of slow, and of rapid sand-filtration respectively, and the second chapter dealing with the design, construction, and working of slow, and of rapid sand-filters. Following these four principal chapters of the book, is a chapter giving a summary of the relative merits of the two methods of filtration; instances in which a combination of the two methods might be advantageous; and brief descriptions of the Anderson, Pasteur-Chamberland, Worms, and Maignen filtering processes. The book concludes with a chapter on the location, design, and construction of filtered-water reservoirs.

The slow sand-filtration method for the purification of water is well known, and its efficiency has been fully established by long experience in England; and it appears to be the only method, aided by aëration, by which very turbid and polluted river waters, such, for instance, as the waters of the tidal River Húgli, which have to furnish the supplies for Calcutta and Howrah, can be sufficiently purified to serve for a domestic supply. Rapid sand-filtration is a comparatively novel method of purification; and the sand filters for this process consist usually of a layer of coarse grains of quartz sand, 2½ to 3 feet thick, placed in a tank of steel, iron, or wood, from the bottom of which the filtered water is led, through strainers to prevent the escape of the sand, into pipes for conveying away the supply for distribution. Aluminium sulphate has hitherto proved the most suitable coagulant, in which the sulphuric acid enters into combination with the calcium or magnesium carbonate in the water, setting free the aluminium hydrate which forms flocculent masses with the fine suspended matter in the water, and, adhering to the grains of sand as the water passes through the filter, covers them and the bed generally with a gelatinous film, which arrests the bacteria as well as the finest particles in the water, and ensures the efficiency of the filter. When the filter becomes clogged by these impurities, as indicated by a reduction in the flow through it, the bed of sand has to be stirred up and pure water forced up through it to remove the sediment. A rapid flow is less liable to be interrupted by frost; but the proportion of coagulant required in a rapid filter changes with the varying composition of the river water, and necessitates the constant supervision of an experienced chemist to regulate the dose to the conditions, for too small a quantity would reduce the efficiency of the purification, and too large a dose would impregnate the filtered water with alum, and, during the period of low alkalinity in the flood stage of the river, would leave free sulphuric acid in the water, which would be injurious to the pipes.

INTELLIGENCE AS THE SOUL OF THE UNIVERSE.

Modern Natural Theology; With the Testimony of Christian Evidences. By Frederick James Gant, F.R.C.S., &c. Pp. xii+151. (London: Elliot Stock, 1901.) Price 2*s*. 6*d*. net.

IT is no doubt true that the older form of the "argument from design" is more or less discredited by the doctrine of evolution. Nevertheless, the author of the book before us is justified in holding that the argument itself is not disposed of, and that in a setting more strictly accordant with our present knowledge than that which Paley gave it, it is still a powerful weapon in the hands of the natural theologian. More, indeed, is gained under the conception of organic growth than is lost by the sacrifice of the older teleology; for Paley's statement of the case savours of deism, whereas under the more recent view there are distinct indications in the universe of a purpose which may be called moral. In so far as such a purpose is discoverable in nature, to that extent does deism retire into the background. This is the aspect of the matter which is put forcibly, if not very intelligibly, in the work before us. The difficulties inherent in the materialistic as well as the deistic position are, on the whole, well stated, and the way is shown to be open for the recognition of intelligence as the "mind or soul of the universe." Though the author guards himself in words which are capable of an orthodox interpretation, it may be questioned whether the argument from nature, in his way of presenting it, necessarily excludes pantheism. Mr. Gant would probably appeal to the second part of his book—which, dealing as it does more particularly with historical evidences, is somewhat outside our province—as supplying the needful corrective. On the whole, however, it must be allowed that, though his personal convictions are not in doubt, his reading of natural phenomena is more successful as a criticism of the deistic position than as an attack on pantheistic interpretations.

The book would have been better adapted for its purpose if its author had developed his argument in simpler language and with stricter attention to the ordinary rules of composition. Instances of confused diction are numerous; for example:—

"In all sentient living beings, mind is much moved by suffering for the maintenance, and thence the prolongation of life" (p. 54).

"Thus living beings tell their own story of identification with living species, or declare their bygone existence as extinct species" (p. 62).

Here Mr. Gant's meaning can only be guessed at. In other cases, though the sense may be easy to grasp, the language shows an almost Thucydidean disregard of grammatical construction. The following passage may serve as an instance :—

"This law of orderly sequence . . . is unlimited in the extent of its operation ; and having produced the face of Nature she now presents, so, doubtless, will the portrait change in the future" (p. 68).

Here is a not unfair specimen of the author's way of overloading his sentences :—

"The moveable coccyx terminates in a blunt point, which . . . is a rudimentary *tail*; with which so many animals are provided, with diverse uses, in climbing, *e.g.*, some apes ; as an additional leg in bounding, or a formidable weapon for striking, *e.g.*, the kangaroo" (p. 40).

This calls for criticism in more respects than one.

We pass over Mr. Gant's views on the subject of heredity. They are open to question, but the main point at issue is immaterial with regard to the purpose of the book. The like may be said of a curious misuse of the term "natural selection" on p. 42. The reference to spiders and scorpions as "insects" is less excusable.

It is fair to state that the abrupt and disjointed style—to use no harsher terms—into which the author so frequently falls does not appear to reflect a corresponding incoherence of thought. Within certain limits, his chapters give the impression that what he has to say, if he could only express it fitly, would be worthy of attention. It is unfortunate that he has failed to find a more attractive method of imparting conclusions many of which are in themselves sufficiently sound and sensible.

OUR BOOK SHELF.

The Distribution of Rainfall over the Land. By Andrew J. Herbertson, Ph.D., F.R.S.E. With 13 maps and a plate. (London: John Murray, 1901.)

EVERY meteorologist will be most glad to possess this very valuable work on the distribution of rainfall over the earth's surface. Dr. Herbertson seems to have spared no pains to utilise all the available material, and the result is that he is able to present us with rainfall maps for every month in the year, giving not only the seasonal distribution of rain, but a knowledge of the actual amount. Each map is accompanied by general remarks as to the position of the pressure belts, wind systems, and other useful information which are fundamental in studying the weather from month to month. Further, a map, with descriptions, &c., is given, illustrating the mean annual rainfall over the land surface. The book includes also a very useful set of curves showing the monthly distribution of rainfall in percentages of the annual fall for seventy-four selected stations. From these it can be seen at a glance whether a station receives the majority of its rainfall at one period of the year, such as Bombay, Pekin, Bathurst, &c., or whether there are two periods of rainfall each year, as at Colombo, Lagos, Peshawar, &c. The importance of keeping separate the rainfall that is received at one place during a year at the two monsoons and not combining them when there happen to be two periods of rainfall is of fundamental importance at the present day, and the volume before us will help to show when the yearly mean alone may be used. Dr. Herbertson concludes this valuable addition to the meteorological library by giving the data he used in drawing the maps, namely a useful bibliography, and tables showing each station, latitude and longitude of each, the period over which rainfall observations have been made, the altitude, and, lastly, the mean rainfall for the period for each month.

Tierleben der Tiefsee. Von Oswald Seeliger. Pp. 49. (Leipzig: W. Engelmann, 1901.) Price 2*s*.

THIS is a popular exposition, by a well-known and thoroughly competent zoologist, of the leading features of deep-sea life and of the conditions under which it exists. It is, of course, primarily for German readers, and is evidently, and very properly, intended to direct attention to the recent German Deep-Sea Expedition. The results of the preceding "Plankton" Expedition are also referred to. The little book contains about fifty pages, of which the first thirty constitute the essay proper and the remaining twenty are notes upon paragraphs and statements in the text, and give references to the literature of the subject. In such limited space it is obvious that no exhaustive treatment is possible; many important matters are barely mentioned, and in fact the whole can only be regarded as, at most, a sketch of this large department of oceanography.

The subjects dealt with are :—depths, pressure and its effects, the distribution of temperatures, the penetration of sunlight, the deep-sea deposits, the question of food, the bipolar theory of distribution, the presence of very ancient animal types, the so-called "living fossils," and the "phosphorescence" of the sea, with some account of the light-producing organs of certain Crustacea and fishes. There is also scattered through the pages a certain amount of discussion of the characteristics and distribution of deep-sea animals.

The essay is illustrated by one coloured plate entitled "Tiefsee-Idyll," showing, not too clearly and without sufficient delicacy of detail, about twenty species of deep-sea animals belonging to various groups. It is intended to demonstrate the characteristic colours, and especially the red coloration of so many abyssal Crustacea, Echinodermata and Cœlenterata when they are brought to the surface. Both in drawing and colouring, however, the plate is rather crude, and probably gives an incorrect impression by showing so many different kinds of animals packed so close together in a very small area.

W. A. H.

A Guide to the Shell and Star-fish Galleries (Mollusca, Polyzoa, Brachiopoda, Tunicata, Echinoderma and Worms), in the British Museum (Nat. Hist.). Pp. v + 130; illustrated. (London: Printed for the Trustees, 1901.)

THIS admirable little work, written by Messrs. Smith, Bell and Kirkpatrick and sold for sixpence, may be described as the best and cheapest elementary natural history of the groups of which it treats hitherto published. A large number of excellent text-figures (some original and others borrowed from well-known works) illustrate the leading external and anatomical characters of the more important types. And although in certain places the text is necessarily somewhat technical, the diagrammatic illustrations render the meaning and application of the special terms so easily understood that every reader ought to experience little difficulty in gaining a general idea of the various groups described. This feature of the work is specially noticeable in the case of the polyzoans, whose structure often forms a stumbling-block to the beginner; and we know of no other book containing such a number of excellent figures of this group in such a small space.

The authors have not been unmindful of the economic side of zoology; and the reader will find much to interest him concerning pearls, cameos and oysters. The nomenclature has been, in the main, brought up to date, the trumpet-shell figuring as *Lotorium variegatum* in place of the familiar *Triton tritonis*, while *Scala*, instead of *Scalaria*, stands for the precious wentletrap.

A Text-book of Astronomy. By Prof. George C. Comstock. Pp. viii+391. (New York and London: D. Appleton and Co., 1901.) Price 7*s.* 6*d.* net.

IT is an excellent sign that among recent works dealing with astronomy there have been some in which methods of teaching the elementary parts of the subject have formed a notable feature. The book under notice is to be regarded as one of this class, as the author, a well-known American astronomer, has endeavoured to "concentrate attention upon those parts of the subject that possess special educational value." The importance of observations with simple appliances is strongly insisted upon in the preface, but from this point of view the book is distinctly disappointing. It is true that in the earlier chapters an attempt is made to introduce practical exercises, some of them observational and others involving the construction or study of drawings; but this admirable beginning is by no means consistently followed up. In fact, the greater part of the book does not strike us as being other than a general outline of the chief facts and principles of astronomy suitable for ordinary reading, except that at intervals the reader is expected to pause and answer a question, such as "What is the magnitude (of Algol) 43 days after a minimum?" The practical method, however, might well have been further adopted; a telescope of adequate power for the demonstration of many phenomena, such as the sun's rotation, can be cheaply and easily constructed, and graphical exercises might have been more frequently introduced with advantage. We notice, also, that the use of a globe in illustrating celestial motions is not mentioned at all. Nevertheless, so far as it goes, the practical work described will be of great value to students, and will doubtless encourage them to further efforts in the same direction.

The book touches upon nearly every branch of astronomy, and the explanations and descriptions are both concise and clear. The numerous illustrations have been selected and reproduced with great care, and, as the author remarks, are worthy of as careful a study as the text; the diagram on p. 153, illustrating the path of the moon with respect to the sun, deserves special mention.

An Introduction to the Practical Use of Logarithms. By F. G. Taylor, M.A., B.Sc. Pp. vi + 63. (London: Longmans, Green & Co., 1901.) Price 1*s.* 6*d.*

THERE can be little doubt that much time is lost by students and others who have occasion to make numerical calculations through unfamiliarity with the practical advantages of logarithms. In the present little book, however, by the consistent employment of the simplest arithmetical illustrations, the author goes far to remove the mystery in which, to many students, the subject appears to be involved by fuller theoretical treatment. The explanations are clear throughout, and these, together with the numerous carefully selected examples, should enable a student of ordinary intelligence to quickly master the use of logarithmic tables. The tables themselves occupy but six pages, two for logarithms, two for reciprocals and two for anti-logarithms. A chapter on methods of rough calculation, intended to verify the results obtained by the use of logarithms, forms a valuable addition to the book. The general subject is excellently illustrated by the application to problems in mensuration, and the whole is brought well within the range of students who have no knowledge of algebra.

LETTER TO THE EDITOR.

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The Moon and Wet Days.

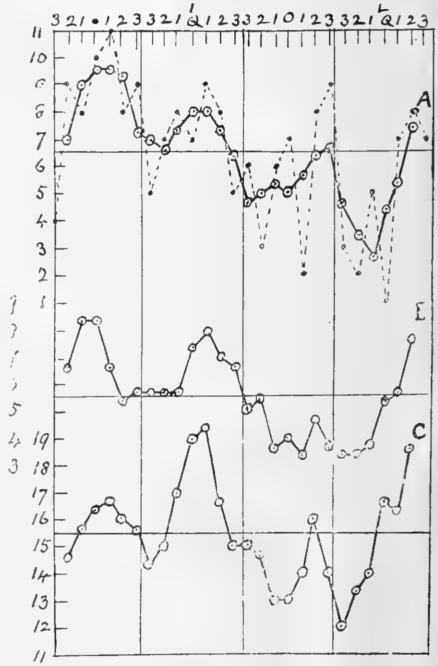
THOUGH it is counted heresy in some quarters to associate weather with the moon, the following results of a recent inquiry into the subject, whether held to be proof of lunar influence or not, might, I think, be of interest to many.

The period considered is the last 24 years. The data (which are for Greenwich) are these:—

(A) Days with ·5 in. of rain, or more, *in the year.*

(B) Days with ·4 in., or more, *in the summer half* (April to September).

(C) Days with ·2 in., or more, in the summer half.



The method in each case was first to ascertain the distribution in seven days about each of the four lunar phases (*i.e.* how often each of those 28 days had rain amounting, *e.g.*, to ·5 in., or more), then smooth the series with averages of *three.*

Both smoothed and unsmoothed curves are given in the case of A; but only the smoothed curves for B and C.

From the fact that four weeks does not quite cover the time of a synodical revolution of the moon (which is about 29½ days), there are a few wet days in each class not coming under any of the above categories. These may perhaps, with regard to the purpose of the inquiry, be left out of account. The totals dealt with are: A, 182 days; B, 158; and C, 433. These come short of the actual totals by A, 7 days; B, 8; C, 28.

Turning now to the curves, the recurrence of four long waves in the smoothed curve for A (less pronounced in C and B), may be noted, in passing, as a remarkable feature.

All the smoothed curves agree in presenting a minimum between the full moon and the last quarter (the third, second, or first day before last quarter). As to the maximum, it is about new moon in A and B, the first quarter being not much below; but in C the first quarter comes into prominence.

The salient facts of A might be put in this way. If all the wet days (182) were uniformly distributed throughout the four weeks, each group of three days would have about 20 cases of that degree of wetness (·5 in. or more). Now the lowest group (about the day before last quarter) has 8, and the highest (say about new moon) has 29, or nearly four times as many. The corresponding numbers for B are: av. 17, min. 10, max. 25; and for C, av. 46, min. 36, max. 58. The contrast becomes less marked as we lower the limit.

Individual days have some interesting features. Thus the third day before the last quarter has never, in these 24 years (summer half) had as much as ·4 in. of rain; and last quarter day has had such only once.

The data of Class A were further dealt with in this way. The odd years were treated as one group, and the even years as another. Both agreed in giving a minimum between full moon and last quarter. The maxima were about new moon in one case, and about first quarter in another.

In view of the present position of the moon-and-weather question, I content myself with merely giving these facts and inviting criticism.

It might happen that another 24 years would obliterate those distinctions, putting others in their place. Should the same relations continue in future, it would appear that in the few days before last quarter we have the best chance of escaping days which would be considered thoroughly wet.

ALEX. B. MACDOWALL.

NORTH AMERICAN FOLKLORE.[1]

ALTHOUGH the habits and surroundings of the American Indians are undergoing a gradual change through the advance of western civilisation, and their original conditions of life are disappearing, yet, thanks to American enterprise in the fields of archæology and folklore, the records of such things are being faithfully kept that they may not entirely die out or become vague tradition. It is with this object that two valuable papers on Arizona have been published in Part 2 of the "Seventeenth Annual Report of the Bureau of American Ethnology," the first dealing with the Navaho *hogáns* or houses, and the second giving an account of excavations in Arizona in 1895. The former, by Mr. Cosmos Mindeleff, contains, not only his material, but also much of the late A. M. Stephen, who lived for many years among the Navaho. The Navaho Indians now occupy a reservation of more than eleven thousand square miles in the north-eastern part of Arizona and north-western corner of New Mexico, the whole tract lying within the plateau region, and under modern conditions they are slowly developing into an agricultural tribe, although they still retain their pastoral habits. It is with the curious customs relating to the building of *hogáns* or houses by this people that the author has concerned himself, and he has elicited many interesting facts about them. The Navaho are accustomed to build two kinds of *hogán*, one for the winter and one for the summer; the former resemble mere mounds of earth hollowed out, yet they are comfortable and excellent for their purpose, and although they are of rough appearance their builders conform, not only to custom, but even to what amounts almost to ritual in their construction, with inaugural ceremonies of the most elaborate description. There is no attempt at decoration; a framework is formed of interlocked forked timbers, to which are added stout poles for the sides, and the whole is covered with bark and earth. Usually a *hogán* can be finished with the help of the neighbours in one day, and in the same evening begins the dedication. The goodwife sweeps and garners the new house, while a fire is kindled inside directly under the smoke hole. The head of the family then comes in and, after rubbing a handful of dry meal on the five principal timbers and strewing some on the floor, begins to chant the following:—

"May my house be delightful,
From my head may it be delightful,
To my feet may it be delightful,
Where I lie may it be delightful,"

and so on. The Navaho have a tradition that they were taught hut-building by the God of Dawn, while to the tribes of the plain were given skin lodges, and to the Pueblo stone houses. Long ago, when First-man and First-woman were living in the lowest Underworld, their dwelling was the prototype of the present *hogán*, and some say that instead of a covering of bark and earth its poles were wrapped in a film of sunbeams and rainbows. This Underworld was peopled by monsters who also lived in huts built after the same fashion, but of different materials. In the east dwelt *Tiéholtsodi* in a house of cloud, with Thunder guarding his door, while in the south sat the Frog in a dwelling of blue mist. The western mirage afforded a home to the Salt-woman, before whose door the Water-sprinkler dances, and towards the north the Blue Heron built himself a *hogán* of green weed with the Tortoise as his gate-porter. When mankind had ascended to the present or fourth world by the power of the Magic Reed, the kindly Dawn God taught them the methods of building that were best fitted for their several conditions. The *hogán* is but a temporary habitation, as is obvious from the following Navaho custom: When an Indian dies within a house, the beams are pulled down over the corpse while the remainder is usually set on fire, and the ruin then becomes *tabu* to the tribe for a long time to come.

The second and larger part of the volume is an account of the excavations which were carried on in 1895 by Dr. Walter Fewkes among the ruined pueblos and dwellings of Arizona. His object was to examine the ruins in the valley of the Rio Verde and the neighbourhood, as well as various other ruins, in order to solve certain problems connected with American archæology. The Moki or Hopi Indians, who now inhabit the limited area called Tusayan, claim to be descended from the pristine inhabitants of its ancient villages, and Mr. Fewkes was well fitted to conduct such investigations, having spent several summers previously among these tribes.

The ruined dwellings of the Rio Verde may be classified into three divisions. First, the pueblos, or independent habitations, that is to say those dwelling-places, ancient or modern, which are isolated on all sides from cliffs. Secondly come the cliff houses, with some part of their walls formed by the natural rock as it stands; and thirdly we find the cavate dwellings, where the rooms are excavated from the cliff wall. Dr. Fewkes carefully examined the latter class, of which so many exist on the left bank of the Rio Verde, and he considers that this side of the river in ancient times must have swarmed with people. In many of the chambers the fireplace was easily discovered, and many more had their ceilings blackened with smoke. In the neighbourhood were a few pictographs on rocks very similar to those found in Colorado, Utah and New Mexico.

Among his other explorations, Dr. Fewkes excavated part of the ruin of Awatobi, which is the connecting link between the prehistoric civilisation of Sikyatki and modern Tusayan life. It was one of the largest Tusayan pueblos in the middle of the sixteenth century, and notices of its mission occur in contemporary documents. We

[1] "The Annual Report of the Bureau of American Ethnology." J. W. Powell, Director, Washington. (Seventeenth, Part 2. 1898, pp. 277; Eighteenth, Part 1, 1899, pp. lvii+518.

find a certain Don Pedro de Tobar sent on an exploring expedition by Coronado, in the year 1540, into the province called Tusayan, which, in Coronado's letter translated by Hakluyt, is spelt "Tucano." His party consisted of about twenty men, chiefly on horseback, and when they had reached the outskirts, they hid themselves for the night under the edge of the mesa, where the Indians found them next morning armed and drawn up in line. The Indian chief scattered a handful of meal across the path, thereby meaning that they should have no passage into the pueblo; but during the parley by an accident the two parties came to blows, and the Hopi were worsted, though without loss of life. These latter then brought their conquerors presents, and Tobar here received the homage of all the province.

Both at Awatobi and Sikyatki Dr. Fewkes' diggings met with success, and he was fortunate in his discoveries. The latter place yielded up antiquities which, it is maintained, show no Spanish influence, and it is to this place we must look for the aboriginal culture of the fifteenth century. Tradition says that Sikyatki was destroyed before the advent of the Spaniards, and no mention of it can be found in documents relating to this district and period. Further, no fragment of glass or metal, or indeed anything that could give token of European civilisation, was discovered in the excavations. The pottery found at Awatobi resembles that of Sikyatki, but bears little likeness to modern ware, and the symbols used in decoration on vessels found at either of these places are very similar. Comparatively few stone axes, hammers or spearheads were found, but arrowheads were common, and many fragments of obsidian were to be seen scattered over the ruins of Tusayan. From the living rooms of Awatobi were obtained a large number of bone needles, awls and whistles, and it is probably only because the principal excavations at Sikyatki were carried on in the graves that more were not found at this latter place also. Dr. Fewkes has gone very fully into the question of the pottery, and his analysis of the markings and symbols is amplified by excellent illustrations both in black and white and in colours. The whole volume is an earnest of the increasing interest taken by Americans in the science of folklore, and future ethnologists will owe a great debt of gratitude to Mr. Mindeleff and Dr. Fewkes and their staff for their untiring energy in labouring in these fields.

Part I of the eighteenth volume contains part of the material gathered by Mr. E. W. Nelson during several years' sojourn among the Eskimos, and well bears out his statement that "the Eskimauan family or stock constitutes one of the most remarkable peoples of the world." In 1877 Mr. Nelson was stationed at St. Michael, in Alaska, and was thus able to study and observe the Eskimos of the Bering Straits until 1881, when he was appointed naturalist to an expedition to northern Siberia. His researches were continued on this expedition, and it was only through ill health that he was prevented from publishing the results of his labours immediately after his return. Even now, with the publication of this volume of more than five hundred closely-printed pages, a large section of his work remains to be elaborated.

The western Eskimos, with whom Mr. Nelson was principally concerned, inhabit an area which he calls the "Alaskan-Arctic" district, which includes the treeless coast belt, from three to one hundred miles in width, stretching from the peninsula of Alaska northwards to Point Barrow. The aboriginal inhabitants of the greater part of this tract, although separated by no physical barriers, can be divided up into well-defined groups characterised by distinct dialects. As a race they are very hardy and insensible to cold, but from exposure to damp are very liable to consumption and rheumatism, and but few live to an advanced age; in stature they vary in different tribes, some averaging no more than five feet two or three inches. Hitherto, before the arrival of traders, the land provided them with all their needs; reindeer, both tame and wild, and seal afforded most of the necessaries of life, and although wild reindeer are now being gradually exterminated, seals are still a profitable source of income. Eskimo clothes consist, for the most part, of reindeer skin, while a kind of waterproof frock is made from seal intestines. The cold, of course, necessitates the use of ear-flaps, gloves and mittens, while in the matter of personal adornment, besides tattooing, the Alaskan Eskimo wear what are known as "labrets," two small pieces of ivory, generally sickle-shaped, placed in holes specially bored for the purpose in the lower lip. Their implements and domestic utensils have been exhaustively described, but space does not allow of our going into details. We may note, however, the method of obtaining fire by the ubiquitous fire-drill, *i.e.* from the heat set up by the rapid friction of a stick against soft wood, which was in common use among the Eskimos of these regions, and the curious implements known as "snow-beaters," for beating snow from boots and clothing. Stone appears to be still very generally used for wood-cutting and skin-dressing, though the metal tools obtained from traders are now ousting the older material.

Among the fauna of these districts are to be reckoned the reindeer, mountain sheep, bear, wolf, mink, fox, lynx, beaver and marmot, but since the introduction of firearms the reindeer have woefully decreased in numbers. The Eskimos, though they have some idea of sport in some of their pursuits, have little forethought in their methods of hunting, and have sometimes killed off a whole herd of deer that has been driven into a *cul-de-sac*. On the other hand, it is held to be a test of endurance for a hunter to pursue a deer-calf on foot and run it down without shooting it, tiring it out so that it allows itself to be captured. The natives are adepts at all forms of trapping and snaring, and pass no small part of their lives in seal-stalking and tomcod-catching.

But the most interesting part of the volume is that devoted to an account of the habits, customs and traditions of this people. In Eskimo villages the centre of all social life is the *kashim*, a building essentially for men, from which women, although they frequently bring food thither, are at certain festivals rigidly excluded. It is the recognised place of oral instruction where the old men hand down the traditions of the clan to the younger generation, the sleeping place of all the unmarried men of the village, and the common house of welcome for guests. With regard to the views of moral obligation held by the Eskimos, Mr. Nelson considers that the only feeling of conscience appeared to be "an instinctive desire to do that which was most conducive to the general good of the community," which is, after all, an excellent fundamental principle of society. Stealing from the same village or tribe is regarded as wrong, but in the case of a stranger or another tribe there is no moral restraint provided the theft does not inculpate the robber's own community. Blood-feuds exist, and we find a custom very similar to the vendetta of Corsica and Sardinia prevalent among the Eskimos, and it is a commonplace among them that a man who has committed a murder may easily be recognised by the restless and watchful expression of his eyes. Marriages are sanctioned in various ways. Among the Unalit, when a young man falls in love he leaves his parents to arrange matters with those of his inamorata, and then, arrayed in his best, goes down to her house and, after presenting her with a new trousseau, leads her home. Burials vary in different places: at St. Michael the dead are buried in a sitting posture with the knees drawn up, while on the

Lower Yukon the position of the corpse is similar, but the head is forced forward between the knees. At Cape Vancouver exist certain memorial image-posts of driftwood, set up near the sea, either representing the human figure or with a rude representation of some totem on the top, which are said to be monuments to those who have died either in landslides or at sea, and whose bodies have never been recovered. Among certain tribes a great Feast to the Dead is celebrated, extending over five days. It is the usual thing, when a person dies, for the next of kin to present food, drink and clothing to the departed spirit, through the medium of the dead person's namesake, at the first festival to the Shades after the death takes place. For some years this continues, the men in the village each giving to their ancestors offerings of various kinds, which are saved up by the chief mourners, in whose hands they are deposited, until it is considered that the village possesses a sufficient hoard of gifts to admit of a Great Festival being held. A certain date having been fixed upon, a kind of summons is issued to the Shades at the next minor festival; invitation stakes, decked with the totems of each departed spirit, are planted before their graves, and songs of invitation are sung. After the observance of this great feast, which Mr. Nelson describes in its entirety, an Eskimo is held to be exempt from further rites and duties to the dead until another near relation dies, when the process begins again.

The Eskimos, from the Kuskokwim River northward, have a regular system of totem marks. Mr. Nelson tells of a villager on the Lower Yukon who explained the totems to him thus: "All of our people have marks which have been handed down by our fathers from very long ago, and we put them on all our things." For instance, among the clan which bears the wolf totem the men fasten a wolf tail to their belts, while the women twine pieces of wolfskin in their hair, and it is customary among them to mark their weapons with their totem, that thereby (according to the author) they may assume the qualities of such animals and become especially deadly. With regard to the adoption of totems we may notice the following story, told by a villager whose sign was a red bear. Once upon a time one of his ancestors, who was a celebrated hunter, while out one day after small game with only blunt arrowheads in his quiver, came across a large red bear. Nothing daunted, however, he let fly arrow after arrow, and—so runs the tale—having succeeded in breaking all its bones, killed it. From that time forth he and his descendants used the red bear as their totem.

In the cosmogony of the Eskimos it is held that the earth was created by the Raven-Father, who is said to have come from the sky and fashioned it when everything was a watery chaos. Now although the earth had been formed, it was as yet devoid of inhabitants, and for the first four days Man lay ensconced in the pod of a beach-pea. On the fifth day he burst the pod and came forth a fully developed Man, and while he was still looking about him the Raven flew up. "Where have you come from?" says the Raven; and the Man points to the empty shell of the pea. "Ah!" replies the Raven, "I made that vine, but never expected that anything like you would come forth from it." So he takes Man away and shows him how to satisfy his hunger with berries. Like other animals in the stories, the Raven possesses the power of assuming human form by the simple process of pushing up his beak like a mask, and during his colloquy with Man has availed himself of this. The Raven then fashions some reindeer in clay and, drawing down his mask, waves his wings four times over them and they at once receive life; but as they were only dry in spots when they came into existence, their skins are dappled and they become the tame reindeer of semi-domesticity. A pair of wild reindeer are also formed, and while the bellies are allowed to dry white, the remainder is kept moist, and by this means the wild reindeer, which to this day are of a light colour only underneath, are brought into being. Then the Raven thinking of Man's loneliness, retires a short distance and moulds an image in the shape of Man, fastening a long tuft of grass at the back of the head for hair. With a wave of the Raven's wings as before, the clay doll is transformed into a beautiful young woman, who in a short time bears the Man a child. They take the child to the riverside and smear him all over with clay, and in three days he becomes a full-grown man.

One day Man asks the Raven about the sky, and at his request the Raven takes him up to heaven and shows him the land he has made there—a beautiful country peopled by a small race—and after being made welcome there he returns through a star-hole to earth. But after a time the Man hungers to return to the little people in the sky, and he goes up again with the Raven. During his absence, however, the earth-people increase so that the animals are in danger of extermination, and this rouses the anger of both Man and the Raven. So they catch ten reindeer, which at this time have long, sharp teeth, and let them loose one night on earth to ravage and destroy. For two nights these fearful beasts attack houses and destroy the inmates, but on the third the villagers bedaub their walls with a paste made of fat and berries, so that when the wild herd again begin to batter the walls with their teeth, the sour berries cause them to rush about shaking their heads so violently that finally all their sharp teeth drop out, and this is the reason that all reindeer teeth are now small and harmless.

Another quaint story is the tradition which explains the reason why the women in the north are deft with the needle, while those of the south dance so nimbly. Long ago the northland was inhabited by men only and no woman had come among them; but it was noised abroad that far away in the south one woman dwelt alone. So one day one of the northerners set his face southward and journeyed until he reached the woman's dwelling, and in course of time he married her and congratulated himself that he had a wife while the son of the headman of the north was still a bachelor. But meanwhile this same bachelor was travelling south with like purpose, and he came on the house while the man was talking within, and, hiding himself, waited until night fell. Then he forced a way in, and, seizing the woman, began to drag her away; but the noise awoke the husband, who leapt forth and grasped his wife's feet as she was being dragged through the door. Both men pulled violently and to such effect that the poor woman's body was torn in half, and the robber went off home with the upper part, while the legs were left behind. Then the rightful husband carved a body of wood and fastened it to the legs, and the other man completed his half in a similar way, and as soon as they had finished, each addition received life, and out of one woman were made two. But although the woman of the south could dance featly, her wooden fingers prevented her from embroidering; and the woman of the north, by reason of her wooden legs, excelled only in needlework, and it is from these two that the women of the north and south sprang, inheriting their several characteristics.

With this story we must take leave of Part I. Mr. Nelson has done his work excellently, and the matter has been arranged in a careful and scientific manner. The Bureau of American Ethnology is greatly to be congratulated, both on the indefatigable workers whose services it has secured and on the excellent way in which it has published their researches. We shall look forward to the remainder of Mr. Nelson's work on the Eskimos with interest.

SOME SCIENTIFIC CENTRES.

II.—THE LABORATORY OF WILHELM OSTWALD.

THE year eighteen hundred and eighty-seven is memorable in the history of physical chemistry; it witnessed the publication of van 't Hoff's discovery of the identity of the laws of gases with those of dilute solutions; and it was the year in which Arrhenius in a classic memoir enunciated his theory of electrolytic dissociation; for the University of Leipzig it had a special significance, as it was then that Ostwald succeeded Wiedemann in the chair of physical chemistry and founded, with van 't Hoff, the *Zeitschrift für physikalische Chemie.* Heidelberg, it is true, had been the first to devote a special chair to the new subject, and Kopp had held it from 1864; but Kopp devoted his time almost entirely to research, and it remained to Wiedemann, who, in 1871, was appointed to the newly created chair at Leipzig, to institute a school for the investigation of these new problems. In 1887 he gave place to Wilhelm Ostwald, confining himself thenceforth to the study of pure physics, of which he had been made professor.

Ostwald was born in Riga on September 2, 1853; at an early age he devoted himself to the study of physics and chemistry at the University of Dorpat, where he "*habilitierte*" in 1878. After teaching there for two years he was made "ordentlicher Professor" at the Riga Polytechnic, which position he held until called to Leipzig in 1887.

The Leipzig laboratory, in which he worked until 1897, was situated in the "Landwirtschaftliche Institut," an old pile originally devoted to agricultural chemistry, and in every way unfitted for the carrying on of those delicate experiments which brought Ostwald to the forefront of scientific workers. Research was carried on under countless difficulties; the light was bad, the rooms unventilated, the heating effected by means of stoves difficult to regulate and producing dust which caused much injury to the finer instruments; no precautions had been taken in laying the foundations to ensure the deadening of vibrations; thus many experiments were ruined; the lack of space precluded the use of telescopes for reading scales, and altogether it would have been difficult to construct a laboratory worse adapted for physico-chemical investigations. But in spite of all these drawbacks the laboratories were soon overcrowded, and additional benches had to be fitted up in the corridors and cellars to accommodate the increasing numbers.

FIG. 1.—Ostwald and van 't Hoff. (Taken in Ostwald's private laboratory.) The illustration shows the two investigators standing by Prof. Ostwald's apparatus for automatically registering on a strip of paper the peculiar phenomena attending the solution of metallic chromium in acids.

(The author of this article begs to acknowledge his indebtedness to Mr. C. W. Foulk, who kindly placed this most interesting photograph at his disposal.)

In 1897 the University and the Saxon Government gave proof of their appreciation of the importance of the new science and of Ostwald's services by placing at his disposal a new specially erected Physico-Chemical Institute, equipped with all the accessories that modern ingenuity has devised.

The work of Ostwald is intimately associated with the theories of van 't Hoff and Arrhenius. In an address delivered in 1891 before the sections of physics and chemistry at the yearly meeting of the German men of science, Ostwald described what his own and the general attitude was towards the views put forward by these two men.

"The consequences connected with van 't Hoff's discovery being so important and wide-reaching, it had in general a friendly reception, though a few scientific men attempted a slight resistance. . . . All the uneasiness connected unavoidably with important revolutions had been directed against a second idea, which, appearing somewhat later, removed a fundamental difficulty in the theory of solutions, which had until that time made its acceptance impossible for me. This idea has nevertheless shown itself as an aid to investigation to be of unparalleled sweep and value; it is the theory of electrolytic dissociation of Arrhenius. . . . No scientific idea produced in my time has helped me in such measure as these two theories. . . . In particular the extraordinarily manifold and severe test, which lies in the numberless numerical consequences of the theories in all possible fields, has yielded such a number of confirmations that the relatively rare cases where the unprejudiced decision was insufficient entirely vanish."

In 1867 Guldeberg and Waage published their investigations on the subject of mass action, and enunciated the law that the intensity of the interaction of two substances was proportional to the product of their active masses, and to a coefficient which depended on the nature of the substance, temperature, &c.

This induced Ostwald, in 1877, to carry out a long series of experiments with the object of determining, by volumetric and optical methods, the manner of distribution of a base among different acids present in excess, and hence calculate the "specific affinity coefficients" of the latter.

In 1884 he suggested another method for the determination of these coefficients; it consisted in measuring the velocities of reactions induced by them, such as the inversion of cane sugar, the decomposition of acetamide, methyl acetate, &c. The results he obtained in this way were found to confirm generally those obtained in the previous series of experiments, as a comparison of the numbers in the subjoined table shows:—

		Velocity Constants.	
	Avidity.	Sugar Inversion.	Decomp. of Acetate.
Hydrochloric	100	100	100
Nitric	100	100	91·5
Sulphuric	49	53	54·7
Oxalic	24	18·6	17·4
Orthophosphoric...	13	6·2	—
Monochloracetic	9	4·8	4·3
Tartaric	5	—	2·3
Acetic	3	0·4	0·35

In 1887 came the theory of electrolytic dissociation; it explained at once the relationship which had been observed both by Arrhenius and by Ostwald between the affinity coefficients and electric conductivities; the degree of dissociation of an acid being a measure of its strength, and the conductivity being due principally to the hydrogen ions, it would follow from theoretical considerations that the conductivities of solutions of different acids would be proportional to the number of hydrogen ions in the solution, and so to the relative strength of the acid. Ostwald pointed out that the application of Guldeberg and Waage's law to electrolytes should enable us to obtain a "dissociation constant" for each electrolyte, the determination being made by means of conductivity measurements.

He then proceeded to trace the relationships between the "dissociation constants" of organic acids and the structure or constitution of the radicals. He showed that they varied with the nature of the acid radical, and that an increase of the negative group such as O, Cl, Br, I, CN, &c., increased the tendency of the hydrogen

FIG. 2.—Ostwald and Arrhenius.

ion to split off, while an increase of the positive radical, such as H, NH_2, &c., decreased this tendency.

The theory of electrolytic dissociation was further extended by Ostwald to explain the colours of solutions; he found that the absorption spectra of dilute solutions of different salts with similarly coloured ions are identical. In conjunction with Nernst he investigated the absorption spectra of a number of salts of permanganic acid, fluorescein, eosin, &c., and confirmed the corollary of the theory of Arrhenius; the colour of a dilute solution of a salt was thus shown to depend on the colour of the free ions present in the solution, the absorption of a completely dissociated electrolyte being the sum of the absorptions of the positive and negative components.

In 1897 he collected and published in four volumes the more important investigations which had been carried on during the previous ten years under his direction; they included work in nearly every department of physical chemistry; among them were the famous experiments on the theory of the electrical charges of ions; Beckmann's original papers on the theory and use of the ebullioscope and crioscope; Nernst's classical memoir on the osmotic origin of currents, and many other important contributions to our knowledge of electro-chemistry, the theory of cells, polarisation and contact electricity.

But Ostwald's labours have not been confined purely to research. In addition to his great efforts in the development and propagation of the new views on solutions and electrolytic dissociation, his name is associated with a number of treatises of varying scope, all stamped with his own originality. In 1885–1887 appeared his famous "Lehrbuch der allgemeinen Chemie"; and two years later his "Grundriss," which has since passed through three editions and been translated into several languages. In the "Grundlagen der analytischen Chemie" (1894) he approached the subject from an entirely new standpoint, while his "Grundlinien der anorganischen Chemie" (1900) bids fair to become one of the standard text-books.

Prof. Ostwald has told us how, more than fifteen years ago, he and his friend Arrhenius, walking along the banks of the Mälarsee, tried to picture the then nebulous future of physical chemistry. In 1887 the new science had so far advanced that he was able, with the assistance of van 't Hoff, to found a journal to be devoted entirely to it, the *Zeitschrift für physikalische Chemie*. The progress which it has since made has gone far to justify even the wildest hopes; and to that progress few have contributed more than the present director of the Leipzig Institute.

F. H. N.

THE DEVELOPMENT OF CHEMICAL RESEARCH.[1]

IF Justus Liebig had no other claims on the gratitude of posterity, we should still be indebted to him for the part which he played in emphasising the value of chemistry as an educational factor. He it was who first showed the importance of practical work in any scheme of scientific training; and, as Kolbe has pointed out, it was from the Giessen laboratory that that system emanated by which a student commenced with qualitative exercises, passed on to quantitative analysis, then to a series of preparations, leading up finally to independent research. Liebig's success in stimulating pupils to original thought is evident from a brief survey of the classical memoirs that were worked out in his laboratory, and of a few of the more illustrious of his numerous "schüler," including as they did such names as A. W. Hofmann, Strecker, Fresenius, Playfair, Williamson, Wurtz and Frankland.

[1] "A Select Bibliography of Chemistry, 1492–1897." By Henry Carrington Bolton. Section viii. Academic Dissertations. Pp. iv+534. (Published by the Smithsonian Institution, City of Washington, 1901.)

The Giessen methods were at once adopted in the several laboratories which began to arise towards the close of the earlier half of the nineteenth century—at Göttingen in 1836, under the direction of Wöhler, and later at Marburg and Leipzig, by Bunsen and Erdmann. They have been accepted by all the great teachers who followed after, from Kolbe, Kekulé and Wislicenus to Victor Meyer, Hantzsch and Curtius; and they are in vogue to-day, not only throughout Germany, but in nearly every country where chemistry is taught. Germany, however, had a long start; in France it was not till the end of the late 'sixties that Wurtz succeeded in persuading the Government of the necessity for reform in the methods of scientific training; and in Great Britain, although the College of Chemistry—the present Royal College of Science—was founded as early as 1845, it is only comparatively recently that public attention has been aroused to the inevitable result of continued apathy.

The publication of the eighth section of Mr. Bolton's laborious compilation, "A Select Bibliography of Chemistry," the first volume of which appeared in 1893, completes the undertaking begun in 1888; the entire work contains rather more than 25,000 entries. In such a vast undertaking as this, omissions are unavoidable; the collection of titles for a fourth volume is, however, in progress, and will afford an opportunity for making the list more complete.

The present volume, as its title indicates, is devoted exclusively to academic dissertations; it is not intended to serve as an index to the chemical memoirs that have appeared in periodicals, but only as a list of those that have been printed independently, the Russian titles being contributed by Prof. A. Krupsky, of St. Petersburg.

An analysis of the contents reveals the fact that during the period covered by the bibliography, namely from 1492 till 1897, no less than 4800 theses on chemical subjects have been handed in at German universities; allowing for omissions, the correct number would probably be considerably more than 5000.

France comes next on the list with a total of, roughly, 1500. Switzerland follows with 600, and Russia with 120; the other countries are all below 100.

When we remember that Germany has some twenty-two universities with splendidly equipped laboratories, maintained either completely or in part by the Government, not to mention the numerous technical colleges, these figures are not to be wondered at.

A better idea of the respective outputs as regards research of these different countries may be gathered from the fact that Germany has six periodicals devoted to the publication of pure chemical research; these are the *Annalen*, the *Berichte*, the *Journal für practische Chemie*, the *Zeitschrift für physikalische Chemie*, the *Zeitschrift für analytische Chemie* and the *Zeitschrift für Chemie*. France has the *Annales de Chimie et de Physique* and the *Bulletin de la Société Chimique*; a certain number of chemical memoirs appear also in the *Comptes rendus*; the other countries are represented chiefly by the journals of their respective societies.

Looking back over her record, Germany may well be proud of those illustrious teachers who did so much to build up her educational system; the rapid strides of German industries in recent years pay eloquent testimony to the success and value of their efforts. At the present time in England the Government is at last waking up to the necessity for action; the growth of technical schools throughout the country is a move in the right direction. But much still remains to be done. Research in every department of science must be stimulated at all costs, and British manufacturers must abandon their old empirical methods. A "research chemist" is worth more than eighty pounds a year, and we must at last realise that the spirit of economy may be carried to fatal excess. The outlook is far from cheerful, and so long as the development of research is entrusted to indifferent and irresponsible authorities it is difficult to hope for better things. Scientific discoveries may not increase the beauty of the earth, but we live in a practical age and must be practical. To be lulled by a sense of false security is to commit national suicide.

INTERNATIONAL ENGINEERING CONGRESS.

THE International Engineering Congress to be held at Glasgow from Tuesday to Friday next week, September 3-6, will be an important congregation of representatives of all branches of engineering practice. The Congress may almost be regarded as a federated meeting of technical societies, for seven of the nine sections are in charge of such organisations. The suggestion that technical societies should hold simultaneous meetings this year in Glasgow was made by the Institution of Engineers and Shipbuilders in Scotland, and it developed into the scheme for an International Engineering Congress.

Lord Kelvin has accepted the honorary presidency of the Congress, and Mr. James Mansergh, F.R.S., is the president. Mr. Mansergh will deliver a short address on Tuesday, and the members will afterwards meet in their respective sections in the University buildings. A large number of papers are to be read, and among them several of scientific interest. The following is a list of the sections, and of a few of the subjects to be brought forward for discussion :—

Section I.—Railways.—Chairman, Sir Benjamin Baker. The economy of electricity as a motive power on railways at present driven by steam, by Prof. C. A. Carus-Wilson.

Section II.—Waterways and Maritime Works.—Chairman, Sir John Wolfe Barry, K.C.B., F.R.S. Novel plant employed in transporting the excavations on the Chicago Drainage Canal Works, by Mr. Isham Randolph ; the improvement of the Lower Mississippi by the Mississippi River Commission, by Mr. J. A. Ockerson ; irrigation in the Nile Valley and its future, by Mr. William Willcocks, C.M.G.; recent improvements in the lighting and buoying of coasts, by Mr. D. Stevenson, and by Baron de Rochemont.

Section III.—Mechanical Engineering (Institution of Mechanical Engineers).—Chairman, Mr. W. H. Maw. Effect of temperature on cooling water in high speed automobiles, by Prof. H. S. Hele-Shaw, F.R.S. ; trials of steam turbines for driving dynamos, by the Hon. C. A. Parsons and Mr. G. Gerald Stoney ; application of metric system to workshops, by Mr. Arthur Greenwood ; power required to drive marine engine works and for electric lighting, by Mr. James Crighton and Mr. W. G. Riddell.

Section IV.—Naval Architecture and Marine Engineering (Institution of Naval Architects).—Chairman, the Right Hon. the Earl of Glasgow. The chief characteristics of the naval development of the nineteeth century, by Sir Nathaniel Barnaby, K.C.B.

Section V.—Iron and Steel (Iron and Steel Institute).—Chairman, Mr. William Whitwell. Report on the nomenclature of metallography, by the committee of the Iron and Steel Institute ; on the spectra of flames at different periods during the basic Bessemer blow, by Prof. W. N. Hartley, F.R.S., and Mr. Hugh Ramage ; on iron and copper alloys, by Mr. J. E. Stead.

Section VI.—Mining (Institution of Mining Engineers).—Chairman, Mr. James S. Dixon. Presidential address, by Sir William Thomas Lewis, Bart. ; alternating currents, and their possible application to mining, by Mr. S. F. Walker ; a new diagram of work, by Mr. H. W. G. Halbaum.

Section VII.—Municipal Engineering (Incorporated Association of Municipal and County Engineers).—Chairman, Mr. E. George Mawbey. Research into the system of sewage purification by bacterial and other methods, by Mr. K. F. Campbell ; treatment of sewage, by Lieut.-Col. A. S. Jones, V.C. ; sewage disposal, by Mr. A. B. M'Donald.

Section VIII.—Gas Engineering (Institution of Gas Engineers).—Chairman, Mr. George Livesey. Electrolysis of gas pipes, &c., by Dr. Leybold ; water gas as an adjunct in the manufacture of coal gas, by Prof. Vivian B. Lewes ; Emile Gobbe's process for the production of water gas, by Mr. Fernand Bruyere.

Section IX.—Electrical (Institution of Electrical Engineers).—Chairman, Mr. W. E. Langdon. Electricity supply meters of the electrolytic type, by Mr. J. R. Dick ; Kelvin's electric measuring instruments, by Prof. M. Maclean ; continuous-current dynamo design, by Mr. H. A. Mavor ; the use of electricity in the propulsion of road vehicles, by Mr. A. R. Sennett.

Advantage will be taken of the presence of a large number of engineers in Glasgow to open the new "James Watt Engineering Laboratories." These laboratories are being erected and equipped at a cost of more than 40,000*l.*, the funds being raised partly by subscriptions from the citizens of Glasgow and neighbourhood, partly by a grant of 12,500*l.* from the Bellahouston Trust, and the remainder from funds already at the disposal of the University Court. Lord Kelvin will preside at the opening.

Arrangements have been made for visits to works of interest to members of all branches of engineering, and for a number of excursions. There will also be a banquet, a reception by the Lord Provost, and a ball, so that the social aspects of the Congress are pleasing to contemplate. These pleasures, combined with the meetings of the sections and visits to the International Exhibition, should make the Congress memorable to all who take part in it.

NOTES.

THE seventieth birthday of Prof. Eduard Suess, who for more than forty years has occupied the chair of geology in the University of Vienna, and is universally regarded as the greatest of living geologists, has called forth hearty greetings from all parts of the world. Prof. Suess was born in London on August 20, 1831, his father being at that time a merchant in the City ; but, while a sympathetic friend of England, he has always remained a true Austrian, and his life-work as geologist, palæontologist and politician has been carried out in his own country. His researches, while largely palæontological, have covered a wide range, and they have led him to grasp more fully than others the problems in the ancient physical geography of the earth, which he dealt with in his brilliant work, "Antlitz der Erde." As remarked by a correspondent in the *Times*, Prof. Suess, to his own countrymen, "has been much more than a distinguished pioneer in science. He has been a living example of enlightened patriotism and devotion to the public welfare, and an indefatigable reformer, whose works will long remain a monument to his memory."

AMONG the many objects that attracted attention during the recent meeting of the International Congress of Zoologists at Berlin, few were more noteworthy than a large mounted adult male gorilla, exhibited by Herr Umlauff, of Hamburg. This specimen is remarkable not only for its size, which rivals, if it does not exceed, that of any example of the gorilla previously obtained, but also because its exact history is known. It was shot by Herr H. Pascen, of Schwerin, the representative of a Hamburg mercantile firm, in Yaunde, in the interior of the German Colony of Kamerun, about fifteen days' journey from the coast, on April 15, 1900. It has been hitherto generally believed that the gorilla is only to be found in Gaboon and the adjoining districts of French Congo immediately under the Equator; but it now appears that the range of this Anthropoid Ape extends further north into the interior of Kamerun. The specimen in question has, as we are informed, been acquired by Mr. Walter Rothschild for the Tring museum.

THE fifth International Congress of Criminal Anthropology will be held at Amsterdam on September 9–14.

THE death is announced of Admiral de Jonquières, who became a membre libre of the Paris Academy of Sciences in 1863, and was renowned for his works in geometry.

IN addition to the papers already mentioned to be read before the Zoological Section at the forthcoming meeting of the British Association, it is hoped that Mr. J. Stanley Gardiner will give an account of his recent researches upon the coral islands of the Maldives.

A REMARKABLE discovery of Palæolithic implements has lately been made on the estate of the Marquis of Ailesbury, at Knowle Farm, on the borders of Savernake Forest. Between 200 and 300 implements (according to a report in the *Times*) have been obtained from a pit which has been opened in a high-level valley gravel. The implements, which are mostly made of flint, have been well fashioned, and some have been finely polished, as if from the effects of blown sand. They include forms familiar from the Somme valley, and also from Hoxne and other places in this country.

THE new milk standard adopted by the Board of Agriculture will come into force on September 1. The regulations state that when a sample of milk (not being sold as skimmed, or separated, or condensed milk) contains less than 3 per cent. of milk-fat, or 8·5 per cent. of milk-solids other than milk-fat, it will be presumed for the purposes of the Sale of Food and Drugs Act, 1875 to 1899, until the contrary is proved, that the milk is not genuine. Where a sample of skimmed or separated milk (not being condensed milk) contains less than 9 per cent. of milk-solids, it will be regarded as not genuine.

THE death of Dr. Adolf Fick, late professor of physiology at the University of Würzburg, is announced in the *Times*. Dr. Fick was born at Cassel in 1829, became professor of physiology at the University of Zurich in 1856, and in 1868 was called to the chair of physiology at the University of Würzburg, a position that he held until his retirement a few months ago. Among his published works may be mentioned a treatise on medical physics, 1857, which passed through many editions; a compendium of physiology, 1860 (third edition 1882); "Anatomy and Physiology of the Senses," 1862; "Mechanical Work and the Production of Heat during Muscular Action," 1882; "Ursache und Wirkung," 1882; "Versuch über die Wahrscheinlichkeiten," 1883. Prof. Fick was also an active contributor to the leading scientific reviews, and furnished many important papers to the records of his University.

THE Paris correspondent of the *Lancet* announces that legal authority has just been given for the creation of a fund for scientific research. It is divided into two sections, and its object is the promotion of purely scientific work relative (*a*) to the discovery of new methods of treatment of the diseases which attack man, domestic animals, and cultivated plants; and (*b*) to the discovery, apart from the medical sciences, of the laws which govern natural phenomena (mechanics, astronomy, natural history, physics, and chemistry). The income of the fund will be derived from the following sources:—(1) Grants made by the Government, by the departments, by the communes, by the colonies, and by other sections of the population. (2) Gifts and bequests. (3) Individual or collective subscriptions. (4) Grants deducted from the portion of the proceeds of the *pari-mutuel* assigned to philanthropic or charitable purposes locally; the annual amounts of these grants, which will not be less than 125,000 francs (5000*l.*), will be fixed each year on the application of the council of management by the special commission held at the Ministry of Agriculture. (5) Interest of money invested in Government securities or deposited with the Treasury. The fund is subject to the authority of the Ministry of Public Instruction, and is managed by a council assisted by a technical commission concerned with the grants.

THE New York Board of Health has distributed a circular of information, prepared by Dr. H. M. Biggs, upon the cause and prevention of malarial fever. This course has been taken because malarial fever is prevalent in certain boroughs of New York City, and is likely to extend on account of the extensive excavations and consequent formation of rain-pools in various parts of these boroughs, if means are not employed for its prevention. The circular states that the following simple precautions suffice to protect persons living in malarial districts from infection:—(1) Proper screening of the house to prevent the entrance of the mosquitoes. The chief danger of infection is at night, inasmuch as the Anopheles bite mostly at this time. (2) The confinement and continuous screening of persons in malarial districts who are suffering from malarial fever. (3) The administration of quinine in full doses to malarial patients to destroy the malarial organisms in the blood. (4) The removal of the breeding places of the mosquitoes through drainage, filling up of holes and surface pools, and emptying of tubs, pails, &c., which contain stagnant water. (5) In pools which cannot be drained or filled, the destruction of the mosquito larvæ by the use of petroleum thrown upon the surface, by the introduction of minnows and other small fish which eat the larvæ, or by both methods.

THE removal of the astronomical instruments from the Observatory at Pekin, as a part of the German loot, has already been mentioned in these columns. No particulars of the action have come under our notice, but the right of Germany to the instruments has just been questioned, so that the subject is still under discussion.

WITH the intention of directing attention to the cultivation of the vine in the colonies, Sir James Blyth, Bart., contributes to the *Chamber of Commerce Journal* for September an instructive article upon vine culture. His remarks upon the value of scientific investigations in connection with the industry are of interest. It is pointed out that owing to the invasion of phylloxera, and the consequent scientific discoveries for its prevention or extermination, labour on the vineyards has become continuous throughout the year. It is a common remark amongst the present proprietors of the Médoc, that in their fathers' time the vines were simply pruned, the land ploughed four times a year, and the grapes gathered at the vintage, leaving all else to nature and the seasons. Now, from the moment the grapes are gathered, scarcely a week—certainly not a month—passes, but some process for the defence of the roots, the stems, or the leaves takes place. The greater care exercised in planting, and the experience acquired in combating all the enemies to the well-being of the vine, promise not only to conquer these insidious fungoid and insect pests, but vastly to increase the proportional productivity of the areas under vines. For instance, there has been a considerable increase in the fecundity of the vine since steps have been taken to regenerate the vineyards which have been affected by phylloxera. This may be judged by the fact that, whereas in 1875, which, as is well known, was a record year in France for quantity as well as quality, an exceptional average yield of 294 gallons per acre was produced, the average yield in 1900 was as much as 343 gallons per acre.

PROF. OTTO NORDENSKJÖLD is at Malmö, Sweden, making arrangements for his South Polar Expedition. A Reuter message says he has made the following statement to a Press representative as to the plan and object of his expedition :—"As soon as the *Antarctic* returns from the expedition which she has made to Spitsbergen for meridian measurements, we start from Göteborg, certainly not later than October 1. From Göteborg we shall proceed to England, and thence to Buenos Ayres and Tierra del Fuego, whence we shall make our way to the Antarctic regions. We shall endeavour to push as far south as possible with the *Antarctic;* and, when winter comes on, we shall send a party on shore to winter. That party will probably consist of six persons, of whom I shall be one. We shall build a small hut for ourselves, and engage in meteorological, magnetic, hydrographic, and other scientific observations. As soon as we have landed, the *Antarctic* will return to Tierra del Fuego ; and a scientific observer, who will sail with her, will conduct the researches in that hitherto little explored country. In this way we shall be able to work in two detachments, and make as much use of our time as possible. Prof. Ohlin, of Lund, and M. K. A. Andersson will accompany me as zoologists. Dr. Bodman will come as hydrographer and magnetician, M. Skottoberg as botanist, and Dr. E. Ekolof as medical officer. Captain Larsin, who has already made several voyages to South Polar regions, will be in charge of the *Antarctic.*"

FROM a note in the *Times* we see that the British Consul-General at Marseilles reports that artificial indigo is killing the natural product on the French market. The artificial dye already regulates prices. The Badische Company have for two years been making indigo near Lyons for local consumption, while the Höchst Farbwerke are manufacturing synthetic indigo by another process in the same city. Artificial indigo is classed for Customs duty with natural indigo, and, since goods dyed with it are not required to be declared as such, they are sold at similar prices to goods dyed with natural indigo. Lyons dyers of cotton and woollen goods and Lyons dealers in indigo say that natural indigo has been ousted from many dye works, especially since artificial indigo has been prepared by crushing. Small dyers favour synthetic indigo, because they can buy small quantities as required and prices do not violently fluctuate. But, as the vegetable dye gives more solidity to the cloth, it is still likely to be used for military uniforms. Dr. Calmette, of Lille, is said to have patented a process for extracting indigotin from vegetable indigo up to thrice the quantity produced by the more primitive methods. It is curious that the Bengal Chamber of Commerce have recently had to ask the Havre Chamber to abolish a rule under which indigo tendered in that important terminal market must be guaranteed to be manufactured by the "old" process—a serious restriction in view of the many new processes recently introduced. The request has been complied with, and certificates will not be needed after April 1 next. From the Consular report on Frankfurt-on-Main for 1900 it appears that the Badische Company has borrowed 12,000,000 marks for the purpose of enlarging the production of artificial indigo and reducing its cost price. The company now claims to be able to supply one-sixth of the world's requirements. The Höchster Farbwerke are also extending their indigo business. Natural and artificial indigo are both 10 per cent. cheaper than last year, the policy of manufacturers being to keep the price of the synthetic rather below that of natural indigo.

A BUST of Dr. G. Armauer Hansen, the discoverer of the leprosy bacillus, was unveiled a few days ago by Prof. Visdal in the garden of the Museum at Bergen, in the presence of many Norwegian and foreign medical men. We learn from the *British Medical Journal* that an address was delivered by Prof. O. Lassar, of Berlin ; and Drs. Sandberg and Lie, of Bergen, also spoke. Congratulatory messages were sent from all parts of the world, and a letter from Prof. Virchow was read, in which the veteran pathologist, after expressing his regret at his inability to be present, went on to say that Dr. Hansen's work had definitively cleared up a large and difficult field of pathology, and that his name was known and celebrated throughout the whole world as a benefactor of mankind. Dr. Hansen was born in Bergen in 1841, and received his early education in the cathedral college of that town. His first investigation was to work out the significance of the so-called globi, or leprous cells of Virchow, and the results of his observations were published in 1869. He then obtained evidence of the contagious and specific nature of the malady, and the Medical Society of Christiania voted a sum of money for him to continue his research. Further investigations of the peculiar bodies (globi-brown corpuscles) previously referred to were rewarded by the discovery, in unstained preparations, of bacilli which were ultimately stained and proved to be the bacilli of leprosy. This discovery was made in 1873—that is, about ten years before the bacillus tuberculosis was made known to the world by Koch. For years Hansen has repeatedly tried to cultivate and inoculate the *Bacillus leprae,* which is known as Hansen's bacillus, but up to the present fruitlessly. One great point, however, has been gained—namely, that it is now practically admitted by all those engaged in the study and observation of leprosy, that the disease is contagious. In Norway, practical legislation on this basis has given the best results, and leprosy there is gradually and surely diminishing. Dr. Hansen celebrated his sixtieth birthday on July 29, and the tribute to his lifelong work and devotion above recorded will be gratifying to all lovers of science. The King of Norway has conferred upon him the distinction of Commander of the Order of Ola.

A LIST of nearly fifty papers accepted by the committee of Section A of the British Association, for reading at the forthcoming meeting at Glasgow, has been received since the publication of the forecast of the work of the other sections in last week's NATURE. Arrangements have been made for discussions on optical glass, to be opened by a paper by Dr. R. T. Glazebrook, F.R.S. ; energetics, to be opened by Dr. J. Larmor, F.R.S., with a paper on the relation of energetics to molecular theory ; and on the proposed new unit of pressure, to be opened by Dr. C. E. Guillaume. A report will be received from the committees on tables of certain mathematical functions, underground temperature, and the determination of magnetic forces. Lord Kelvin will read papers on the absolute amount of gravitational matter in any large volume of interstellar space, and on "Aepinus atomised." Prof. A. Gray, F.R.S., will read several papers, among the subjects being the influence of a magnetic field on the viscosity of magnetisable solids and liquids, elastic fatigue, and induced currents produced by starting a convection current. The following are among other physical papers :—On a new instrument for magnetic work on board ship, by Captain E. W. Creak, F.R.S. ; on the effect of sea temperature on the seasonal variation of air temperature of the British Isles, by Mr. W. N. Shaw, F.R.S. ; the law of radiation, by Dr. J. Larmor, F.R.S. ; the Michelson-Morley effect, by Prof. W. M. Hicks, F.R.S. ; sur les effets magnétique de la convection électrique, by Dr. V. Crémieu ; on the magnetic field due to the motion of a charged condenser, by Dr. F. T. Trouton, F.R.S. ; on resolving power in the microscope and telescope, by Prof. J. D. Everett, F.R.S.; on the interference of light from different sources, by Dr. G. J. Stoney, F.R.S. ; on a simple method of accurate surveying with a hand camera, by Prof. H. H. Turner, F.R.S. ; on the conduction of electricity through mercury vapour, by Prof. A. Schuster, F.R.S. ; hydrostatic pressure, by Prof. W. Ramsay, F.R.S. ; comparison of constant volume and constant pressure scales for hydrogen between 0 °and - 190° C., by Dr. M. W. Travers and Mr. G. Sentor ; and the laws of electrolysis of alkali salt vapours, by Dr. H. A. Wilson. Mathematical papers are promised by Major P. A. MacMahon, F.R.S., Lieut.-Colonel A. Cunningham, Prof. A. G. Greenhill, F.R.S., Mr. C. V. Boys, F.R.S., and others. There will also be papers on astronomical subjects by Prof. H. H. Turner, F.R.S., Rev. A. L. Cortie, and Prof. D. P. Todd.

THE death-rates from accidents of various kinds in mines in the United Kingdom are dealt with in detail, both numerically and graphically, by Dr. Le Neve Foster, F.R.S., in his latest report, published as a Blue-book. The improvement which has been made may be judged from the fact that, whereas, in the early fifties, the underground death-rate was more than five per thousand, the average death-rate of the underground workers in 1900 was only 1·445. In 1851 about nineteen persons were killed per million tons of coal raised from mines, but last year the death toll on the same quantity of coal was reduced to four persons. Naked lights are still the principal cause of the accidents, more than seventy-five per cent. of the total number of deaths being ascribed to their use. In connection with the description of miscellaneous accidents we notice with interest the remark that during a severe thunderstorm in Staffordshire electricity passed down a shaft, and two men received a severe shock. Flashes of light were seen about pipes near the shaft. The following is a complete list of explosives which have passed the special test for use in mines, under conditions far more stringent than those of the ordinary list: ammonite, amvis, aphosite, cambrite, carbonite, electronite (second definition), kynite, Nobel Ardeer powder, Nobel carbonite, roburite (No. 3), saxonite, special bulldog, thunderite, and virite. As to electric safety lamps Dr. Le Neve Foster says the Sussmann Company have informed him that three or four thousand of their lamps are employed in collieries in the United Kingdom. It is of interest to notice that the total number of mechanical coal-cutters in use in the United Kingdom in 1900 was 311, of which 240 were driven by compressed air and 71 by electricity. The quantity of coal got out by these cutters was 3,321,012 tons. Gold mining is being successfully carried on in North Wales; 19,463 tons of quartz crushed at St. David's mine yielded on an average about 14dwts. of gold to the ton, and the net profits for the year amounted to nearly 40,000*l*.

THE Meteorological Office pilot chart of the North Atlantic and Mediterranean for the month of September shows that West Indian hurricanes have a tendency to keep further out on the ocean in this month than in July and August, the mean point of curvature being in about 28° N., 72° W., and individual cases have been known to curve in the same latitude as far as 52° W. Comparatively few of the centres enter the Caribbean Sea, and of those that do nearly all keep to the northern side. The origin of some of these storms is attributed to shallow disturbances moving westward in the vicinity of the Cape Verde Islands, associated with unsettled weather and strong winds. Hurricanes are rarely experienced on the north coast of South America, Curaçoa island being visited in September 1877, the only instance in seventy years. Local peculiarities in the winds on the African and American coasts are referred to, and there is a summary of the features of the winds of the Grecian Archipelago and also of the currents of the same region. An inset chart represents the third type of thunderstorm conditions over the British Isles, namely those which appear as secondaries to depressions in the north. The ice reports show that in July there was a diminution in the number of bergs seen on the Banks of Newfoundland, few being reported south of the latitude of St. John's. In the strait of Belle Isle and to a distance of about 200 miles north-eastward of Belle Isle itself, the steamer route was infested with great quantities of ice, heavy field ice and large bergs rendering navigation very difficult and tedious. One steamer was detained four days in the ice, another was obliged to retreat and make for the gulf of St. Lawrence by the south coast of Newfoundland. The most southern ice was in 41° N., 47° W., a very small piece, 20 feet by 40 feet, and only 4 feet out of the water.

SOME further particulars are given in *Symons's Meteorological Magazine* for August of the severe thunderstorm which occurred in London on July 25. It was in many respects similar to that which occurred on July 27 last year; both storms occurred after a period of great heat, and after an absolute drought of nearly three weeks. The barometric trace showed distinct disturbance at the two periods of greatest intensity, but there was an absence of the typical thunderstorm curve. The rainfall (2·85 inches in about four hours) has been exceeded on only one day in the forty-four years since the commencement of the Camden Town record, viz. in the great thunderstorm of June 23, 1878, when 3·28 inches of rain fell in an hour and a half. The greatest intensity of rainfall in the recent storm was ·23 inch in two minutes, being at the rate of 6·90 inches per hour. It is remarkable, considering the vividness of the lightning and its great frequency, that so little damage was done.

WE have received the Report of the Director of the Government Observatory, Bombay, for the year ending March 31, 1901. The labours of the observatory are directed in the first place to observations in magnetism, meteorology and seismology, and the discussion and publication of the results; and secondly to astronomical observations for the purposes of timekeeping and navigation. The Dines' pressure-tube anemometer gives very satisfactory results, and serves as a valuable check upon the Robinson velocity anemograph. The seismograph registered twenty-nine earthquakes during the year, besides 447 small and local movements. Among the various important duties performed at the observatory may be mentioned the rating of the chronometers of merchant ships which arrive at the port, and the transmission of weather and other reports to various newspapers and public bodies.

THE *Electrical Review* states that experiments are about to be made on the River Lea with the view to the adoption of a system of electric haulage of barges similar to that in use in France. A power station has been erected at Hertford, from which the current will be supplied by wires supported on poles to a trolley running on a narrow-gauge track along the towpath. It is anticipated that the barges will be towed at a speed of from three to four miles an hour at less cost than by horse traction. The system is to extend to Walthamstow, a distance of eighteen miles.

THE improvements in the locks and bridges, and the deepening of the waterway of the Aire and Calder Navigation, which have been carried out in recent years, have enabled for the first time in the history of the undertaking a sea-going steamer to navigate the canal from Goole to the middle of Yorkshire. The *Pioneer*, after a voyage of 500 miles from Fowey in Cornwall, delivered a cargo of 130 tons of china clay at Leeds. This vessel is $98\frac{1}{2}$ feet long, $17\frac{3}{4}$ feet beam and draws $7\frac{1}{2}$ feet of water. After the inception of the Manchester Ship Canal, several schemes were proposed for making a ship canal from the Humber to the centre of the manufacturing districts of Yorkshire. A proposal to establish a port at Wakefield was enthusiastically received at a meeting of representatives of the West Riding, the estimated cost of the scheme being six million pounds. The financial results of the Manchester Ship Canal have not given encouragement to the further prosecution of these schemes.

DURING the past few years a series of remarkable papers by Prof. Karl Pearson and his coadjutors has been published by the Royal Society in the *Philosophical Transactions* and *Proceedings*, on the foundations of a very comprehensive mathematical theory of evolution. Mr. R. Worthington (*Journal Anat. and Phys.* vol. xxxv. 1901, p. 455) gives some account of that portion of Prof. Pearson's work which bears an osteology as a branch of physical anthropology, in such a manner as shall be intelligible to non-mathematical readers. The application of mathematical analysis to the problems of evolution was introduced by Dr. Francis Galton and perfected by Prof. Karl Pearson, and the results already obtained are of such importance that biologists cannot afford to neglect them.

THAT portion of the brain where "impulses of diverse nature, coming from all regions of the body and from all the sense organs, may meet and play upon each other," that *sensorium commune* for which the ancient philosophers sought in vain for so many ages, is a region of the hemisphere which is surely worthy of a distinctive name. Such is the plea of Prof. G. Elliot Smith (*Journal Anat. and Phys.* vol. xxxv. 1901, p. 431), who suggests that it might be called the *pars crescens* (hemisphærii), in reference to the peculiar characteristic of its rapid expansion in the Mammalia; but instead of selecting a new phrase he prefers to use the term *neopallium*, as at every epoch in the history of the mammal this part of the brain shows a progressive increase in size, whereas the other superficial parts of the hemisphere become relatively or actually smaller and may even disappear almost entirely without any vital injury to the individual.

To the *Proceedings* of the Royal Physical Society of Edinburgh for 1899–1900, Dr. G. Wilson contributes a preliminary notice of the first appearance of the lung in the Australian lung-fish (*Ceratodus*), and a second on the embryonic kidney of the same. Dr. D. Hepburn notices certain mammalian remains (all referable to existing types) recently collected in a cave in Sutherlandshire.

IN the August number of *The Zoologist*, Mr. R. B. Lodge describes an interesting arrangement by means of which he obtained automatic photographs of the purple heron and spoonbill on the nest. A camera was fixed near the nest, provided with a string and catch so arranged that when the bird alighted it caused a "snap-shot" of itself to be taken. Curiously enough, before the photo of the purple heron was obtained, one of a marsh-harrier, which had come to rob the nest, was taken. With the aid of a flash-light the arrangement would be available for night use.

THE Imperial Department of Agriculture for the West Indies issues a continuation of its publications relating to the insects injurious to cultivators in these islands, in the form of a pamphlet on the "Scale Insects of the Lesser Antilles," of which a second instalment is to follow. The West Indian scale insect and allied members of the Coccidæ form, in spite of their minute size, some of the most troublesome pests against which the West Indian planter has to contend. According to the author, Mr. H. Maxwell-Lefroy, various poisonous or resinous washes, applied as spray, form the most efficient remedies; a list of those most suitable to each kind of crop is appended.

To the January issue of the *Proceedings* of the American Philosophical Society, Dr. R. W. Shufeldt contributes a further instalment of his series of dissertations on avian osteology, this contribution dealing with the skeleton of the cuckoos. Although not committing himself definitely to any opinion, and dwelling upon the imperfect state of our knowledge of the bony structure of this large group of birds, the author is inclined to confirm the view of the near relationship of the cuckoos to the plantain-eaters and bee-eaters. He believes, however, that several families of "picarian" birds "have a cuckoo-vein running all through them, strongly impressed in some cases, barely discernible in others. Indeed, these groups of birds seem to have arisen from some very ancient and common stock, but by the extinction of numerous related types . . . it has left in recent times the most puzzling collection that the systematist has to deal with."

THE second part of vol. vii. of the *Transactions* of the Norfolk and Norwich Naturalists' Society contains a number of papers, for the most part connected with the natural history of the county. Prof. A. Newton has a note on some bones of the crane from the Norfolk fens, and this is followed by an interesting account from the pen of Mr. T. Southwell of the breeding of that bird in the county. Documentary evidence is cited to prove that in 1543 cranes nested in Hickling Broad, and about the same time in the Cambridgeshire fens. Dr. S. F. Harmer describes and figures a dolphin taken in Cornwall, the flanks of which showed certain peculiar scratches. At first it was thought these might be due to the hooks of a cuttlefish, but subsequent investigation tended to show that they were made by other individuals of the same species, probably during the pairing season. The author is, however, of opinion that somewhat similar markings seen on other cetaceans may be due to the struggles of the cuttles on which they feed.

THE bulk of Part I of the Bergen Museum "Aarbog" for 1901 is occupied by a list of the Coleoptera and Lepidoptera of the Bergen district, drawn up by Mr. J. S. Schneider, and illustrated with a coloured plate. Of more general interest is an article by Dr. O. Nordgaard on the hydrography of the North Sea, largely based on the observations of two sealing captains. As the result of the investigations it appears that the effect of the Gulf Stream on the North Sea has been very variable during the last four years of the century. The favourable condition of the ice in 1897 and 1898 seems to have been owing to an influx of warmth characterising these years, while the unfavourable conditions noticed in 1899 and 1900 were due to a lack of the same influence. The years 1898 and 1899 severally represented indeed the maximum and minimum in this respect. This is confirmed by the fact that in the former year the development of the "plankton" was much above the average. Allusion is made to the influence of such temperature variations on the cod and herring fishery, as well as on sealing.

MR. W. W. DAVIS has a paper in "Studies from the Yale Psychological Laboratory" (vol. viii.), on some relationships between temperament and effects of exercise. His tests and observations are scarcely sufficient to establish very definite relations, but the conclusions at which he arrives are not without interest. The observations suggest that nervous persons, in training for the development of strength, require light practice, and phlegmatic persons require vigorous practice. The phlegmatic type of temperament is apparently characterised by the presence of much reserve energy of muscle and nerve cell. The nervous type has less reserve energy but a greater ability to use the energy at hand. It is not difficult to apply these principles to practical physical training. They make necessary on the part of the trainer a personal knowledge, secured either by means of observation or experiment, of the temperament of each man under his charge. The amount of work necessary in each case can then be apportioned with much greater exactness. Mr. Davis points out that it seems quite as certain that there may also be a direct application of these principles in the realm of pedagogy. The experiments show that, in the development of strength, mental factors are more necessary than muscular factors. If the principles can be applied to the development of will power and co-ordination, why not to memory, association, imagination, and reasoning as well? All have a physiological basis, and in so far all are governed, in a given individual, by the same principles of growth. There is at least a wide field here for inquiry and practical investigation. There can be no doubt that the present system of secondary and collegiate instruction, which requires an equal amount of work from all pupils, causes much harm to many individuals. Mr. Davis's results emphasise the importance of recognising the individual in the training of either physical or mental ability.

AN elementary text-book of zoology, which has been prepared for the Cambridge Natural Science Series by Mr. A. E. Shipley of Cambridge and Prof. MacBride of McGill University, Montreal, will be published on September 9 by the University Press in England and the Macmillan Co. in New York.

A CATALOGUE of works on chemistry and chemical technology in the library of the Patent Office has just been published as No. 6 of the Patent Office Library Series. The list comprises the titles of 885 works (79 serials, 806 text-books, &c.), representing about 3300 volumes. The titles are classified under 146 headings and sub-headings, so that students using the Patent Office library can readily find the works available upon any subject in chemistry.

THE United States Board on Geographic Names has issued a special report giving the accepted spellings of 4000 geographical words used in the Philippine Archipelago. When the islands were acquired by the United States in 1898, and new charts had to be prepared, much confusion existed as to the geographical orthography—Spanish, Malay, American and English methods of spelling native names being in use. Acting upon the advice of the Board, the U.S. Hydrographic Office adopted the spelling upon the best Spanish official charts and maps, and a list of about 4000 coastwise names was compiled, chiefly from Spanish sources. This is the list which has now been published. Another list, containing about 6000 Philippine geographical names, was prepared independently by Father Algue, director of the Jesuit Observatory at Manila, and these have been accepted by the U.S. Coast and Geodetic Survey for the atlas of the Philippine Islands shortly to be issued. To ensure uniformity, Father Algue has revised the present list, so that all the names in it now agree with those used in the Coast Survey atlas.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. H. S. Kemp; a Japanese Deer (*Cervus sika*) from Japan, presented by Sir Douglas Brooke, Bart.; a Short-headed Phalanger (*Petaurus breviceps*) from Australia, presented by Captain Gordon Wilson; two Common Kingfishers (*Alcedo ispida*), British, presented by Mr. W. Milne; two Rosy-faced Love-birds (*Agapornis roseicollis*) from South Africa, presented by Mrs. Harry Blades; an Alligator (*Alligator mississippiensis*) from Southern North America, presented by Mr. J. Foster Spence; a New Zealand Parrakeet (*Cyanorhamphus novae-zealandiae*), a One-wattled Cassowary (*Casuarius uniappendiculatus*), a Westermann's Cassowary (*Casuarius westermanni*) from New Guinea, two White-breasted Sea Eagles (*Haliastur leucosternus*) from Australia, an Angulated Tortoise (*Testudo angulata*) from South Africa, two Pale-headed Tree Boas (*Epicrates angulifer*) from Cuba, a Common Roe (*Capreolus caproea*), European, two Getulian Ground Squirrels (*Xerus getulus*) from Morocco, deposited; a Spot-wing (*Psaroglossa spiloptera*) from India, purchased; a Burrhel Wild Sheep (*Ovis burrhel*), an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN SEPTEMBER.

Sept. 1. 7h. 36m. Minimum of Algol (β Persei).
4. 16h. 2m. to 16h. 58m. Moon occults ϵ Tauri (mag. 3·7).
6. 10h. 48m. to 11h. 13m. Moon occults 71 Orionis (mag. 5·1).
7. Pallas in opposition to the sun.
9. 14h. 32m. to 15h. 25m. Moon occults κ Cancri (mag. 5·0).
12. Perihelion passage of Encke's comet.
15. Venus. Illuminated portion of disc = 0·795.
15. Mars. ,, ,, ,, = 0·933.
15. 15h. Venus in conjunction with the moon. Venus 1° 15′ N.
18. 12h. 30m. Minimum of Algol (β Persei).
21. 9h. 19m. ,, ,, ,,
27. 6h. 5m. to 9h. 13m. Transit of Jupiter's Satellite III.
28. 6h. 1m. to 6h. 41m. Moon occults 62 Piscium (mag. 6·0).

NEW ELEMENTS OF COMET 1901 (I.).—From observations made in May and June at the Cape and Cordoba (*Astronomische Nachrichten*, Bd. 156, No. 3734), Herr H. Thiele has computed a new set of elements for this comet, giving the following orbit:—

T = 1901 April 24·28845 Berlin M.T.

$$\left.\begin{aligned} \omega &= 203^\circ\ 2'\ 15''\cdot1 \\ \Omega &= 109\ 38\ 53\cdot1 \\ i &= 131\ 4\ 49\cdot3 \end{aligned}\right\} 1901\cdot0$$

$$\log q = 9\cdot388827$$

An ephemeris is also given founded on these revised elements, so that search for the now faint comet may be continued.

Ephemeris for 12h. Berlin Midnight.

1901.			R.A. h. m. s.		Decl. ° ′ ″
Aug.	28	...	8 36 23·21	...	+11 1 14·2
Sept.	1	...	38 55·36	...	10 58 38·1
	5	...	41 16·77	...	10 56 4·5
	9	...	43 27·06	...	10 53 38·9
	13	...	45 25·77	...	10 51 26·9
	17	...	47 12·35	...	10 49 34·0
	21	...	48 46·28	...	10 48 6·1
	25	...	50 7·06	...	10 47 8·3
	29	..	51 14·12	...	10 46 45·9
Oct.	3	...	52 6·91	...	10 47 4·2
	7	...	52 44·72	...	10 48 8·7
	11	...	8 53 6·73	...	+10 50 5·5

BRIGHTNESS OF THE SOLAR CORONA, JANUARY 22, 1898.—In a paper read before the Royal Society, Prof. Turner gives a preliminary description of the results obtained from an investigation into the law of variation of the brightness of the solar corona in relation to the distance from the sun's limb (*Proc.* Roy. Soc., vol. lxviii. pp. 36–44). Instead of the rotating sectors used in previous similar investigations, a graduated gelatine wedge has been employed to diminish the intensity of the comparison beam. An entirely new method has been adopted for representing the results, which has led to the suggestion of a more satisfactory law for the variation of coronal brightness with the distance from the sun.

Up to the present time the relation usually adopted was that formulated by Prof. Harkness in 1878, viz.:—

$$\text{Brightness} \propto \frac{1}{(\text{distance from sun's limb})^2};$$

but this was not in agreement with the visual measures of Thorpe and Abney in 1886 and 1893.

The new relation now suggested is—

$$\text{Brightness} \propto \frac{1}{(\text{distance from sun's } \textit{centre})^6}.$$

Tables giving the measures along six different radii show sufficiently small residuals to warrant the formula being provisionally used to express the variation. It is found that a constant is required to be added to the formula, the physical interpretation of which is most probably the sky-glare present during totality, and which would necessarily give a certain amount of light all over the plate. The total brightness of the corona will thus depend on the area of sky included. Assuming this to be a circular area 5° in diameter, the total brightness of the 1898 corona would be about 2·4 times that of full moon, while the 1893 corona was only about 1·1 times brighter than the full moon.

THE SPECTROSCOPIC BINARY "MIZAR."—During March and April of the present year a series of excellent photographs of the spectrum of this star, ζ Ursæ Majoris, were obtained with Spectrograph IV. and the 33 cm. refractor at the Potsdam Observatory. Dr. H. C. Vogel has measured these, and gives the result of the reductions in the *Astrophysical Journal* (vol. xiii. pp. 324–328). On some of the plates as many as sixty-five lines are recognisable, including several of the strongest iron lines and lines of silicon and magnesium. When the period of maximum separation occurs, however, many of these become faint and the measures are more difficult.

On several of the plates the separated magnesium lines at λ 4481 appeared of unequal width, but no change in their behaviour was discernible after a coincidence.

The values of the relative motion are given for twenty-five plates obtained during the period 1901 March 24–May 1, ranging from 158 to 15 kilometres per second.

The motion of the whole system is given as 16 km. per second. A diagram is given showing the velocity curve most nearly representing the final reduced measures, and the period thus deduced is 20·6 days—considerably less than the period of 104 days deduced by Pickering about 1890.

The following provisional elements have been computed from the curve by Lehman-Filhes' method on the assumed values of

Period = 20·6 days.
Maximum relative velocity of A = 128 km.
,, ,, ,, B = 156 ,,

T_0 = 1901 March 28·60 (Rel. motion in line of sight = 0).
T = 1901 March 28·88.
ω = 101°·3.
e = 0·502.
$\log \mu$ = 9·4843.
μ = 17°·476.
$a \sin i$ = 35 million kilometres.

$$m + m_1 = \frac{4\odot}{\sin^3 i}.$$

NOVA PERSEI.—In the *Astrophysical Journal* (vol. xiii. pp. 336–7) Messrs. G. C. Comstock and J. Stebbins give a very exhaustive series of comparisons of the estimated brightness of Nova Persei from February 24 to May 12. The observations were made by the "grade" method of Argelander, the estimated error being 0·1 magnitude for a single comparison. The rapid variation of the star is well shown by the many cases where several observations were obtained during the same evening. The minimum magnitude recorded is 5·7. Most of the estimates were made with the help of an opera-glass, the comparison stars being those given on Hagen's special chart of the region.

THE FUTURE OF ELECTRIC TRACTION.[1]

IT is not so long since the Englishman, and perhaps more particularly the Londoner, first tasted the sweets of electric traction, but he has already found it so satisfactory, whether as a profitable investment or as a method of travelling at once comfortable, convenient and healthy, that he is clamouring for its rapid extension and development. It is beginning to be realised, too, that electricity as a motive power is not destined to be confined to metropolitan railways and suburban tramways. The electrification of our larger railways is now being discussed as a practical problem by the more far-sighted of our engineers, who have recognised that many of the railway systems characteristic of this country are peculiarly suited for electrical running. Mr. Langdon, now president of the Institution of Electrical Engineers, devoted a paper read last November before that society to the subject; and Major P. Cardew, in his recently delivered Cantor Lectures, again gave prominence to the question.

[1] "On the Supersession of the Steam by the Electric Locomotive." By W. Langdon. (*Journal* of the Institution of Electrical Engineers, vol. xxx. p. 124.)
"Electric Traction." By Major P. Cardew. Cantor Lectures. (*Journal* of the Society of Arts, July 12, 19 and 26.)

It is interesting to consider what are the conditions of working which would make a railway one in which the adoption of electric traction is likely to prove profitable, for unless the alteration results in the increased economy of the system it is clear that it is not likely to be made. "Electric traction," says Major Cardew, "tends towards the ideal of the continuously moving platform," and one may say that the more nearly a railway tends towards the same ideal the more likely is the adoption of electricity as its motive power. In those most closely approaching this limit, namely, the metropolitan railways, all other systems at present known have long been seen (by all except perhaps the directors of the London underground and district railways) to be doomed. The reason lies in the essential difference between steam and electric driving, namely, that in the one case the train must carry its own power generator whilst in the other the power is generated in bulk for a number of trains. Since the generation of power in bulk is much cheaper than in detail, the tendency with steam locomotives is to make each detail as large as possible, and therefore to run heavy trains at long intervals. With electric working, on the other hand, it is desirable to make the load on the generating station as constant as possible, which can only be done when the number of trains is large and each only takes a small fraction of the total load; for in such a case the stopping and starting of individual trains will only have a small percentage effect on the output of power. It will readily be seen, therefore, that for long-distance traffic the steam locomotive is likely for some time to come to hold its own, for here the number of passengers is not so great as to be able to support a very frequent service of light trains, and, moreover, the time taken over the journey, being nearly the whole of the day or night, practically fixes the starting times. With lines communicating between important towns not too far apart (about 100 miles is the limit given by Major Cardew), electric traction could be introduced with advantage; in this case a frequent service of light trains would be a great benefit, especially if a number of important centres lie on the route between the termini and if there is a field for metropolitan traffic at the ends of the line. In such lines our small but densely populated country abounds.

Many additional advantages are introduced at the same time as the principal gain in the lessening of the cost of power generation. Thus the driving power can be distributed throughout the train, which results in lessening the wear of the permanent way and also in a lessening of the slip of driving wheels, as a greater proportion of the weight of the train is used for adhesion. It is easier, too, to provide power for accelerating the train and for mounting gradients, as the extra power needed in these cases is derived from an outside source, whereas if a steam engine were made powerful enough for very quick acceleration it would be too powerful for economical working during the greater portion of its running time. The concentration of power generation at a few centres leads to many economies in working expenses; coal and water are only used at the generating station, and it is only there in consequence that means for their storage and handling have to be provided.

Those who are more keenly interested in this question will do well to read the paper by Mr. Langdon to which reference has been made above. They will there find the matter thrashed out in considerable detail, both in the paper itself and in the discussion upon it, with the estimated saving worked out from a consideration of the existing traffic over a section of the Midland Railway, fifty miles long, between London and Bedford. Major Cardew discusses the problem more generally, but in his third lecture enters with some detail into the equipment of an imaginary typical full-scale railway fifty miles long; for this he arranges a suitable time schedule and then estimates the amount of power required and the approximate cost of equipment.

Major Cardew equips his imaginary railway on the polyphase system, which he considers, on account of "the advantages obtained in regard to means of conversion and from the use of higher pressure," to be most suited for use on full-scale railways. Space does not permit us to enter into a discussion of the relative merits of three-phase and direct-current working, and we must content ourselves with referring the interested reader to Major Cardew's lectures, where he will find the question fully considered. Here, in England, we are not very familiar with polyphase currents, but on the Continent, and in Switzerland especially, there are many railways thus equipped, and there can be no question of the willingness of Continental engineers to introduce their wares into this country if, as is to be feared, we are incapable of supplying our own wants. Major Cardew, after considering and summing up the relative advantages of the two systems, gives his verdict against continuous current and feels "confident in prophesying the successful application of the polyphase system to the working of full-scale railways."

PRIZE-SUBJECTS IN APPLIED SCIENCE.

THE programme of subjects for which prizes will be awarded by the Société industrielle de Mulhouse next year has been issued, and copies can be obtained upon application to the secretary of the Society. In general chemistry, medals will be awarded for the best memoirs or works on the theory of the manufacture of alizarin reds; the synthesis of the colouring matters of cochineal; theoretical and practical study of the carmine of cochineal; study of the colouring matter of cotton; the composition of aniline blacks; physical and chemical modifications which occur when cotton fibre is transformed into oxycellulose; action of chlorine and its oxygen compounds upon wool; constitution of colouring matters employed in linen fabrics; synthesis of a natural colouring matter used in industries; and theory of the natural formation of an organic substance and preparation of the substance by synthesis.

In connection with dyeing, medals will be awarded for the best works presented on the following subjects:—A new mordant which admits of practical use; metallic solutions which give up their bases to textile fibres, and the conditions in which they are most effective; iron mordants and the part they play in dyeing according to their condition of oxidation and hydration; an aniline black which will not deteriorate in the presence of other colours or affect these colours, especially those of albumin; a soluble black for dyeing which will resist the action of light and soap as much as aniline black; a light blue cheap enough to be used to dye wools and not affected by boiling or by light; a blue similar to ultramarine which can be fixed upon cotton by a chemical process; a pure yellow which behaves like alizarin as regards its dyeing properties; a lake-red; a purple; a colouring matter to supersede logwood in its various applications; an assistant especially applicable to wool, capable of being cleared by simple washing, and composed of substances other than tin salts, hydrosulphites, sulphites, and bisulphites; new method of fixing aniline colours; a means of making colours resist the action of soap or of prolonged boiling; a means of producing the sheen of gold and silver upon materials by metallic powders; a manual containing tables showing the densities of as many inorganic and organic compounds as possible, in the crystallised state and in cold saturated solution; the synthesis of a substance having the essential properties of Senegal gum; a substance to supersede egg-white in the dyeing of linen; a colourless blood albumin which can be used instead of egg-white; a manual on the analysis of compounds employed in fabric printing and in dyeing; an indelible ink for marking cotton and similar materials; a practical method of removing grease spots from materials; a memoir on the use of resins in bleaching cotton fibre; a memoir on the bleaching and dyeing of various kinds of cotton; also memoirs dealing similarly with wool and silk; use of hydrogen peroxide for bleaching; improvements in the bleaching of wool and silk; and manuals on the bleaching of cotton, wool, silk, hemp and other fibres.

In connection with fabric printing, medals are offered for an alloy or other substance which has both the elasticity and durability of steel and also the property of not causing any chemical action in the presence of acid colours and colours containing certain metallic salts; a new cylinder machine capable of printing at least eight colours at once; and an application of electricity to bleaching, dyeing or fabric printing.

Among the prize subjects in mechanical arts are:—A means of recording by a graphical method the work done by steam engines in a given period (ordinary indicator diagrams do not fulfil the conditions); memoir on the spinning of combed wool; on the force required to start spinning machines; a motor for driving machines used in printing fabrics.

In electricity medals will be awarded for an electric motor the power and driving rate of which can be easily varied; a memoir on the comparative cost of electricity and gas for lighting a town having a population of at least 30,000; and comparative costs of electricity, gas, acetylene and water-gas for lighting an industrial establishment.

Money prizes as well as medals are awarded for some of the subjects, and all the competitions are open to every one, irrespective of nationality. The memoirs, designs or models submitted for the awards should be sent to the president of the Société industrielle de Mulhouse before February 15, 1902.

PROGRESS OF CIVIL ENGINEERING.[1]

IN response to a request of the Institution of Civil Engineers, Tredgold gave this ever memorable definition of civil engineering in 1828:—

"Civil engineering is the art of directing the great sources of power in Nature for the use and convenience of man; being that practical application of the most important principles of natural philosophy which has, in a considerable degree, realised the anticipations of Bacon, and changed the aspect and state of affairs in the whole world."

After a brief sketch of the objects of civil engineering, he added:—"The real extent to which it may be applied is limited only by the progress of science; its scope and utility will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical art, since its bounds are unlimited, and equally so must be the researches of its professors."

A more concise and comprehensive definition of a great truth can hardly be conceived. From a physical and intellectual standpoint, a nobler aim for the exercise of the mental powers cannot be imagined than the direction of the great sources of power in Nature for the use and convenience of man. Psychology deals with mind alone, physics considers the nature and the laws of matter, but civil engineering treats of the intelligent direction of the laws governing matter so as to produce effects which will reduce to a minimum the time and physical labour required to supply all the demands of the body of man and leave more opportunity for the exercise of the mental and spiritual faculties. Philosophy, physics and civil engineering must work hand in hand. The philosopher must imagine, the physicist prove by experiment and mathematical computation, and the engineer apply to practice the laws of matter. Each must keep himself informed of the progress made by the others and must aid them by suggestions as to the lines on which research needs to be carried forward. The civil engineer, in attempting to solve some problem of construction, finds that he needs a material which shall possess a certain quality which he cannot discover that any natural product possesses. He calls the chemist to his aid, and he, from a study of the combinations of existing forms of matter which most nearly approach the desired ideal, reasons that some special combination of elements will entirely fulfil the conditions, and he experiments to find whether such combination can be made. Sometimes he is successful in his first attempt and sometimes not. But, whatever the result, he has added to his knowledge of the laws of combinations and has furnished to the philosopher fresh data for his generalisations and to the engineer a new material for his use.

As the knowledge of the nature of steel and the precise methods in which it can be manufactured have progressed, the engineer has gradually come to know just what he wants and how it can be produced, and, in his specifications, requires that the particular material of this class which he desires shall be of a certain chemical composition and also possess certain characteristics. The same is the case with almost every material which enters into the construction of engineering works of the present day. Matter in its original state is rarely used. Its chemical condition must be transformed before the engineer can utilise it with any confidence. That almost any desired transformation can be effected was not realised until late in last century. Starting with the atom, the ultimate particle of matter so far comprehended by us, the chemist found that several different kinds of atoms could be identified, and that these would combine in certain ways according to laws which could be formulated. But in the application of these laws and the tabulation of the results gaps were found to exist which could not be filled without the supposition that other elements existed than those already known. The existence of such elemental substances was confirmed by the revelations of the

[1] Abridged from an address delivered at the annual meeting of the American Society of Civil Engineers, June 25, by the president, Mr. J. J. R. Croes.

spectrum analysis, and, later on, several of such elements have been actually identified by the use of the electric current in creating vibrations in the ether. The limit is probably not reached yet, but as each new element is discovered its affinities are sought by the chemist, its sensibility to various forms of vibratory motion are investigated by the dynamist, as we may term the physicist who is seeking the laws of either heat or light or electricity, and then it is the function of the civil engineer to study how it can best be applied to the use and convenience of man. For, ever since the beginning of the nineteenth century, the evidence has been cumulative that matter in motion accounts for all physical phenomena, that motion produces energy, that energy is never wasted but is simply transformed, and that it manifests itself to the senses of man in various modes which are appreciable by the several organs of sense.

What our senses recognise as chemical affinity, heat, light and electricity are simply conditions of matter induced by vibrations or quivers or waves or strains, whatever we may call them, of different kinds and at different velocities. Neither matter nor motion can be originated by man, but, by a careful study of the sequence of events, control can be acquired of their modes of interaction, and natural phenomena can be artificially reproduced and other phenomena be produced. The intelligent application and direction of such means of control is the function of the civil engineer.

In considering the means of directing the great sources of power, the psychological element must not be forgotten. A mere intellectual application of the laws discovered by physical research is not enough to make a civil engineer. Breadth of view, the faculty of analysing what has been done so as to discover how and why some enterprises have been successful and others have not, and the ability to forecast the future, are essential. These qualities are largely natural, but may be cultivated to a great extent by study and experience. That there has been a wonderful advance in this direction during the nineteenth century is shown by the great number of civil engineers who hold positions of prominence in the management and control of large enterprises which require the exercise of faculties which cannot be acquired in any other way than by experience in the designing, construction and management of engineering works.

A prominent factor in causing this advance in engineering science which has occurred simultaneously on the Continent of Europe, in Great Britain and in America, has been the collaboration of men of science. Early in the century it became evident that the multiplication of lines of research demanded a differentiation of the labour of their prosecution and a close cooperation of the workers in any special line, and various associations of specialists were formed to promote various branches of scientific research. By the middle of the century it had become apparent that civil engineering was not the prosecution of a speciality, but was the coordination and direction of the work of all specialities in science and its applications.

Recognising, then, that progress is a law of Nature, the acceleration of progress is the aim of civil engineering. It strives to simulate the results of the slow processes of Nature by causing the sources of power to act rapidly in any desired direction. Appreciating, too, the fact that there is constant progress and that what now seems admirably adapted to our needs may in a short time require to be superseded by improved structures and processes, the tendency of the time is toward the production of works which will have a definite term of life, rather than towards the construction of everlasting monuments. We see that in the old nations, where the effort to build for eternity was made, time has outstripped the intent of the builders and what is antiquated is useless, and we see the same thing in our own streets to-day. The idea of building a monumental structure which will hand one's name down to future ages is a fascinating one, but it is simply a survival of the engineering of the Pharaohs.

The most thorough exemplar of the condition of civil engineering at the beginning of the twentieth century is the modern office building in a great city. One hundred years ago, the man of enterprise who resided fifty miles from a large city and wished to consult an engineer regarding a project for a new canal, arose before daylight, struck a spark from his flint and steel, which falling on a scrap of tinder was blown by him into flame and from that a tallow dip was lighted. In the same primitive manner, the wood fire was kindled on the kitchen hearth and his breakfast was cooked in a pot and kettle suspended from the iron crane in the fireplace. Entering the cumbrous stage coach, hung on leather springs, which passed his door, he was driven over muddy roads, crossing the narrow streams on wooden trestle bridges and the navigable rivers on a ferry boat, the paddle wheels of which were turned by a mule on a treadmill. At last he was landed in the city, where he walked through dirty streets paved with cobble stones until he reached his destination, a plain three-story brick building founded on sand, with a damp cellar and a cesspool in the back yard. Entering a dark hall he climbed a wooden staircase and was ushered into a neat room, rag-carpeted, warmed by a wood fire on the open hearth and lighted by a sperm oil lamp with one wick, for it was dark by this time.

To-day, his grandson, living at the old homestead, while comfortably eating his breakfast, which has been cooked over a gas range, reads in his morning paper that the high dam of the irrigation reservoir in Arizona, in which he is interested, sprang a leak the day before, and he telegraphs to his engineer in the city that he will meet him at his office at noon. Then, striking a match, he lights the lamp of his automobile, which is fed by petroleum brought 200 miles underground in pipes from the wells, rolls over macadamised roads to the railroad station, where he enters a luxuriously appointed train, by which he is carried above all highways, through tunnels, under rivers, or across them on long-span steel bridges, and in an hour is deposited in the heart of the city, where he has his choice of proceeding to his destination through clean and asphalt-paved streets in electric surface cars at nine miles an hour, elevated steam cars at twelve miles an hour, or through well-lighted and ventilated tunnels at fifteen miles an hour. Reaching the spot his grandfather had visited, he finds there a huge and highly decorated building, twenty or more stories high. Founded on the primeval rock, far below the surface of the natural ground, the superjacent strata of compressible material having been penetrated by caissons of sheet metal sunk by the use of air, compressed by powerful pumps driven by steam or electricity generated at a power station half a mile or more away, and these caissons filled with a manufactured rock such as the ordinary processes of Nature would require millions of years to produce, there is erected a cage of steel, the composition of which has been specified, and the form and mode of construction of which have been so computed that the force of the elements cannot overthrow the structure or even cause it to sway perceptibly. The meshes of this mighty cage are filled with products of the earth, the mine and the forest, transformed so as to be strong and light and incombustible, and all interwoven with pipes and wires, each in its proper place and noted on the plans. In one set of these pipes there is pure water, which has been collected from a mountain area of igneous geological formation, depopulated and free from swamps, on which a record of the daily rainfall is kept, and in which impounding reservoirs have been constructed by masonry dams across its valleys. From these reservoirs, the water, after filtration through clean sand, is conveyed thirty or forty miles through steel or masonry conduits to covered reservoirs, whence it is drawn as needed through cast-iron pipes to the building where it is to be used, and there distributed to all parts of it, chilled nearly to the freezing point through one system of pipes or heated nearly to the boiling point through another system. Another set of pipes carries steam which, passing through radiators, keeps the temperature of the air throughout the building at the proper standard for comfort. Sanitary conveniences are provided everywhere, and all wastes are consumed within the building by the surplus heat generated, leaving only ashes to be removed. Wires convey electric currents to all points, so that the occupant of a room, sitting at his desk, can by the touch of a button ventilate his apartment, illuminate it, call a messenger, be kept informed of every fluctuation in the markets, converse with anybody who is not "busy" within forty miles of where he sits and if entirely "up to date" can require his autograph and portrait to be reproduced before his eyes for identification. He dictates his correspondence and his memoranda, and "takes his pen in hand" only to sign his name. He need not leave his seat except to consult the photograph hanging on his wall, which shows to him the latest condition of the mine, the railroad, the arid lands irrigated, the swamps reclaimed, the bridge in progress, the steamship, the water-works, the tunnel or the railroad, the dam, the filter or the sewage works, the town, the machine, the power plant or the manufacturing establishment in which he is most interested.

Entering the brilliantly lighted hallway of this building, the air of which is kept in circulation by the plunging up and down of half a dozen elevators, the visitor is lifted at a speed of 500 feet a minute, past floor after floor, crowded with the offices of financiers, managers and promoters of traffic and of trade, lawyers, chemists, contractors, manufacturers, to the headquarters of the controlling genius of the whole organism, the civil engineer. For he it is to whom all the members of this microcosm must apply for aid and advice in the successful operation of their respective occupations. It is not his to mechanically transform elements into matter, or matter into other forms, or to show how energy may be produced, but to direct the application of energy to the various forms of matter, original or produced, in such way as to bring about the most satisfactory results in the most speedy and economical manner.

He has grown with the growth of the nineteenth century, and is, so far as the relations between man and matter are concerned, its most striking product. And so, while the definition given in the "American Edition of the Encyclopædia," which appeared at the beginning of the century, that "Civil engineers are a denomination which comprises an order or profession of persons highly respectable for their talents and scientific attainments and eminently useful under this appellation," is still true, it is hardly probable that the compiler of the Twentieth Century Encyclopædia will be content to let it stand without further explanation.

But the end is not yet: there are still many problems of Nature unsolved. The experience of every day shows that there are sources of power not yet fully developed, and we cannot but say with the great poet:

> "I doubt not through the ages one increasing purpose runs,
> And the thoughts of men are widened with the process of the suns."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A GOOD estimate of the character of the work of a College or University can be obtained from the investigations carried on by its staff and students. The following statement of research work done in the laboratories of the McGill College, Montreal, last session, published in the Annual Calendar of the College and University for the session 1901–1902, furnishes excellent evidence of sound instruction and scientific activity:—The effect of cold on the physical properties of iron and steel; the influence of bending on the torsional strength of metals; the properties of iron and steel as affected by annealing at moderate temperatures; experiments on frictional losses in 1½-inch pipes and bends under varying velocities of flow; experiments on the determination of the "Miner's Inch"; the separation and concentration of chromite, blende, nickeliferous pyrrhotite and certain other minerals by combined gravimetric and magnetic methods; the crushing and sizing of rocks by means of different types of apparatus; the treatment of Nova Scotia mispickel concentrates by cyanide, bromocyanide and chlorination methods; conditions affecting the wave form of alternators; and the effect of change of wave form in alternators on induction and synchronous motors: induction motors used as frequency changers.

THE Massachusetts Institute of Technology has lately introduced the degree of Doctor of Philosophy to supersede the former degree of Doctor of Science. The following statement of the requirements for the new degree is of interest as showing the tendency of technical education in the United States:—"The degree of Doctor of Philosophy certifies to high attainments of a grade which qualifies the recipient as a scientific investigator and teacher. The course of study leading to this degree is mainly one of experiment and research, accompanied by such other theoretical subjects as may be useful adjuncts to the main scheme of work. The candidate must pursue his studies and researches under the direction and oversight of the Faculty for at least two school years, furnishing from time to time such evidences of progress as the Faculty may require. His attendance must be continuous, except in cases of absence previously approved by the Faculty for the purpose of conducting researches and investigations in the field. He must present a thesis embracing the results of an extended original investigation, and must pass such final examinations as the Faculty may require."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 19.—M. Fouqué in the chair.—The chairman announced the death of two members of the Academy, Admiral de Jonquières and Baron de Nordenskiöld, and added a short account of their life-work.—The relations of psoriasis with neurasthenia: treatment by injections of orchitin, by M. F. Bouffé. Psoriasis is a trophonevrosis having its seat in the nervous centres and especially in the great sympathetic. It presents a great analogy with neurasthenia in its origin; in both diseases there is constantly a diminution in nervous activity, characterised by a fall in the urographic line of phosphoric acid. The treatment of both should consist in the invigoration without stimulation of the nervous system by injections of orchitin, the average dose being from 10 to 12 c.c. three times a week.—On a problem of d'Alembert, by M. F. Siacci.—On a particular critical point of the solution of the equations of elasticity, in the case where the forces on the boundaries are given, by MM. Eugène and François Cosserat.—On the general principles of mechanisms, by M. G. Kœnigs.—On the absolute value of the potential in isolated nets of conductors having a capacity, by M. Ch. Eug. Guye.—Researches on the mechanism of etherification in plants, by MM. E. Charabot and A. Hébert. Etherification in plants is produced by the direct action of the acid upon the alcohol, the action being favoured by a particular substance playing the part of a dehydrating agent, the latter being a diastase the dehydrating action of which is exercised in a chlorophyll medium.—Littoral deposits and movements of the soil during the secondary era in the Quercy and western Rouergue strata, by M. Armand Thevenin.—On the origins of the source of the Loue, by M. André Berthelot. Through the accident of a fire at an absinthe factory and the consequent liberation of a large quantity of absinthe, it became evident that the Loue represents a subterranean arm of the Doubs.—Observations of M. Berthelot on the preceding communication.—Influence of colour upon the production of the sexes, by M. C. Flammarion. A study of the effect of light of various colours upon the development of silk-worms.

CONTENTS.

THURSDAY, SEPTEMBER 5, 1901.

PETROLEUM.

Handbook on Petroleum. By Captain J. H. Thomson and Boverton Redwood. Pp. xix+298. (London: Charles Griffin and Co., Ltd., 1901). Price 8s. 6d.

THE cooperation of Captain Thomson, H.M. Chief Inspector of Explosives, and Mr. Boverton Redwood, author of the encyclopædic "Treatise on Petroleum," in producing a handbook on the subject for the use, not only of officers of local authorities charged with the duties prescribed by the Petroleum Acts, but also of those engaged in the petroleum trade, strikes us as peculiarly happy.

The handbook commences with a short historical introduction, and the authors then proceed to a brief exposition of the theories of the origin of petroleum.

Whereas French and Russian chemists have supported the inorganic origin, a theory which in outline regards the oil as formed by the condensation under pressure of the gases generated by the action of water-vapour on metallic carbides, American geologists and German chemists favour the organic origin of petroleum.

Berthelot and Mendeleeff give the weight of their authority to the first theory, but there seems to be but little doubt that, though it is possible to produce petroleum in this manner, the organic origin is at once more probable and agrees better with the deductions of the geologist.

The supporters of the organic theory are also divided. The school of German theorists, among whom the names of Hofer and Engler stand out prominently, consider petroleum to be of purely animal origin, whereas many American geologists consider certain types, such as the oil of Pennsylvania, to be of vegetable origin.

At the meeting of German men of science and physicians at Munich in 1899, Krämer brought forward the view that petroleum is formed by the decomposition, under pressure, of the wax at the bottom of lakes and seas, which originated in the cells of diatoms; infusorial earth, which consists of the skeletons of Bacillariaceæ, exists in beds of enormous extent in districts where petroleum is found. In the discussion which followed, Engler, whilst admitting that some oil might be formed in this manner, upheld his view that petroleum is primarily derived from the submarine decomposition of fish, substantiating his theory by the announcement that he had found and analysed drops of petroleum from fossil bivalves in the Lias at Rothmatsch: we shall, however, be wisest to consider at present, with the authors of this book, petroleum to be of mixed animal and vegetable origin.

The next chapters are occupied by an account of the sources of supply, by a description of the methods for the production, refining and transport (the value of this section would have been considerably enhanced by diagrams and drawings), and by the enumeration of the names and chief properties of the commercial products of petroleum. Among much other useful information, the difference between "benzene," "benzine," "benzol" and "benzoline" is clearly explained. The next two chapters are devoted to "flash-point" and "fire-test."

The term "flash-point," as defined by the Act of 1879, has given rise to much misconception; it is not "the point at which petroleum gives off an inflammable vapour," but the temperature at which the oil gives off sufficient vapour to form an inflammable mixture with the air, a matter which, as the authors remark, depends entirely on the experimental conditions.

A considerable uniformity was obtained by the adoption (Act of 1879) of the Abel test, but the apparatus is capable of considerable improvement, and this improvement is met with in the Abel-Pensky test, a modification adopted by the German Government, the use of which the authors hope will shortly be legalised in this country. As the flash-point is lowered 1·6° F. for every reduction of an inch in barometric pressure, it is important to introduce a correction depending on the height of the barometer; such a table of corrections is given in this handbook and is used in Germany, but has not as yet received the sanction of Parliament. The Abel and Abel-Pensky tests are described with great detail and clearness, as is also the elegant method for ascertaining the presence of small quantities of petroleum vapour devised by one of the authors, namely by the use of the Redwood test-lamp, the principle of which depends on the halo or "flame-cap" which surrounds the hydrogen flame when burning in an atmosphere containing a small proportion of inflammable gas—the appearance of the flame under these conditions is illustrated by an excellent coloured photograph, and the diagrams throughout this section are most useful.

The rest of the book is occupied by an account of the legislation relating to petroleum and calcium carbide, including the precautions to be taken in the storage of the oil, and remarks on the construction of petroleum lamps. This section, which, like the rest of the book, is extremely clearly written, should be studied by all oil-dealers, lamp-manufacturers and local authorities; we venture to think its perusal would repay "the man in the street."

The law with regard to petroleum in force at the present time is contained in the Petroleum Acts of 1871, 1879, and 1881, but the history of petroleum legislation is one of "laborious attempt and discouraging failure." Subsequent to the Act of 1881, a Bill of fifty-seven clauses was introduced (in 1883) and referred to a Select Committee of the House of Lords; this was followed by a tour of inspection and the drafting, in 1884, of a second Bill, followed in its turn by an extension of the tour to America. In 1888 important conferences were held and memoranda presented to both Houses; the inevitable Bill was introduced in 1891 and a Select Committee appointed in 1894, which was reappointed in 1896 and 1897 and which reported in 1898. In 1899 Mr. Reckitt, a member of the committee, introduced a private Bill to raise the flash-point from 73° F. to 100° F. (Abel test). The Bill was defeated, but the "lobbying" on this occasion was such as to induce Mr. Healy to express wonder whether "all this was pure philanthropy."

The authors proceed to consider the reasons for this want of success. The present Acts are by no means unworkable, and have the merit of simplicity; but they simply control the keeping of petroleum spirit (oil flashing below 73° F.) and in no way interfere with the sale or storage of petroleum oil (oil flashing above 73° F.).

Though the Acts leave everything to the local authority, yet they are deficient in provision for local control; the excessive decentralisation which puts in the hands of district councils throughout the kingdom the administration of such technical legislation cannot but militate against the attainment of the object in view. But the legislative failure is not due to these minor points, but rather to the strong opposition to the raising of the flash-point and to the attempt to prohibit dangerous lamps by legal enactment.

The objections to raising the flash-point are, firstly, that it is uncertain whether this measure would have an appreciable effect in preventing lamp accidents, which are, as a general rule, not caused by explosions, but by over-heating of the gallery and wick-tube and by breaking the lamp, in which cases no oil flashing under 150° F. can be regarded as absolutely safe; and, secondly, that raising the flash-point would indubitably cause a rise in the price of the oil, when there would be tendency to supply petroleum spirit for lighting purposes, this spirit commanding, under present conditions, a higher price than petroleum oil. The administrative difficulty of the prohibition of dangerous lamps must be patent to everybody.

The yearly average of fatal accidents from lamps is 129, and this period represents the lighting, burning and extinguishing of a lamp at least 4,000,000,000 times; now during a similar period, 5500 deaths are caused by falling down stairs, yet no one would suggest that in consequence houses must be restricted to one story; lamp accidents are nearly always caused by lamps being dropped, knocked over or pulled off tables when lighted and occasionally a lighted lamp is used as a missile.

The authors give much sound advice as to the purchase of safe lamps and, in an appendix, add directions for the care and use of petroleum lamps, the circulation of which recommendations in leaflet form by local authorities would doubtless be attended by beneficial results. The concluding chapter is devoted to calcium carbide and acetylene.

The first appendix deals with the imports of petroleum, from which it appears that the import of Russian oil is increasing, whereas that of American is decreasing—the enormous increase in the importation of "petrol," motor-car spirit, is significant; in other appendices the Petroleum Acts of 1871, 1879, and 1881 are given, with comments and explanatory notes; memoranda and forms of license issued by the London County Council and a County Council report on the use of petroleum in manufactures and trades in London are also printed.

The book is well printed, clearly arranged, and possesses a good table of contents and an index; we must warmly congratulate its authors on having produced an altogether admirable handbook of the subject.

W. T. LAWRENCE.

COMMERCIAL EDUCATION.

Commercial Education at Home and Abroad: a Comprehensive Handbook, providing materials for a Scheme of Commercial Education for the United Kingdom, including Suggested Curricula for all Grades of Educational Institutions. By Frederick Hooper and James Graham. Pp. xiv + 267. (London: Macmillan and Co., Ltd., 1901.) Price 6*s.*

THE joint authors of this book are respectively the secretary of the Bradford Chamber of Commerce and the inspector for commercial subjects and modern languages to the West Riding County Council. They have done well to embody the results of their experience in a volume in which the promise held out in its somewhat lengthy title is creditably fulfilled. Very copious particulars are given in regard to the organisation and plans of commercial schools in the chief countries of Europe, notably France, Germany, Belgium and Switzerland. Designs of buildings, regulations and time-tables, both from these countries and from the United States of America, show in considerable detail how ample and varied is the provision made for the systematic teaching of "commercial" subjects, and how much our own countrymen have yet to learn in this department of national education. A considerable portion of the book is thus statistical and is made up of a great variety of official documents; but it is uncritical, and does not profess to do more than set forth existing facts, without discriminating very exactly between those portions of an elaborate programme which are of merely occasional and local importance and those which are entitled to rank as essential in every complete scheme of commercial and economic training.

In dealing with the conditions under which our own tentative efforts after such training have hitherto been made, the authors write with the authority which comes from intimate knowledge, and their suggestions are of much practical value. They rightly insist on the need of a good foundation of general knowledge before any attempt is made to differentiate the course of a boy's instruction in the direction of any trade or profession. But they urge that when the time for such differentiation arrives, there should be as much encouragement offered by public authorities to the training of skilled merchants. as to the education of the skilled manufacturer or artisan. The policy of the Education Office, and the award of special grants and recognition for "Science and Art," have helped to encourage a general belief that all efforts to prolong the education of a youth beyond the ordinary school age and to fit him for the practical business of life should take a scientific direction, the domain of "science" being understood to include chemistry, physics and other studies bearing on material industries and production. "At present," the authors say, "provision is made whereby the science student may specialise in the direction of mechanical and electrical engineering, chemical industries and textile trades. But for the commercial student no such opportunity exists."

The contention that this is too restricted a view of the aims and scope of a technical or continuation school is, in our opinion, well grounded, and ought to lead to a fuller official recognition of the need for variety in Polytechnics and other institutions which do not come necessarily under the designation of "science and art" schools.

The problem how to determine the curriculum of a special school for youths of fifteen or sixteen destined for the conduct of business in a merchant's or banker's office becomes, therefore, one of considerable practical importance, and a large part of this book is devoted to its solution. Prominent among the conditions of success is the practice of *oral* instruction in modern languages, and constant conversational exercise as a necessary preliminary to book work and the technicalities of grammar. "The ear often remains untaught even after the eye has grasped all there is to know of the grammar and construction of the language." In this connection the particulars given in the book respecting the travelling scholarships of Germany and Switzerland and Belgium, and other devices for acquiring practical familiarity with the spoken language, are helpful and suggestive. The authors very properly insist on the need of a thorough acquaintance with arithmetic; but they evidently attach more importance to varied practical exercise in the art of computing, and to its application to tariffs, freightage, exchanges and other technicalities which have a visible and immediate relation to markets and counting houses, than to arithmetic as a science. The best experience on this subject, however, points to the conclusion that the learner whose attention has been directed, by means of demonstrative lessons and by some instruction in algebra, to the theory which underlies the truths of arithmetic, is in a better position to apply his knowledge in after life to business problems, whatever form they may happen to take, than he who has prematurely loaded his memory with rules and terminology relating to the details of commerce. On the subject of geography, and the effect of climate and physical conditions upon the nature and value of products, some hints are given which are well calculated to suggest to teachers more practical and interesting methods of teaching than are generally adopted in geographical lessons. The authors are right also in attaching importance to some knowledge of political economy, a subject which receives a good deal of attention in the higher commercial departments attached to the *Realschulen* of Germany. It is hardly recognised in England yet that the elements of social economics and the general conditions of industrial prosperity, the relative values of different kinds of labour, the laws which govern the rate of wages and the interest of money are subjects which can be made very intelligible and attractive to young people towards the end of their school life, and before entering into the arena of business competition. Such knowledge is not without a moral value of its own, for it reveals to the learner the need of industry, forethought, punctuality, self-restraint and thrift, and goes far to show the relation of conduct to real success in life.

The particulars given in this book respecting the College of Commerce and Politics in the University of Chicago, the Higher Institute of Commerce at Antwerp, the School of Commerce in Neuchâtel, and the commercial courses of University grade at Magdeburg Frankfort, Berlin, Dusseldorf and Leipsic, may serve to remind us of the fact that in England scientific preparation for the profession of commerce has hitherto not been recognised as a legitimate part of University work. A step has indeed been recently taken, thanks to the boundless munificence of Mr. Passmore Edwards, towards the permanent establishment of a School of Economics and of Commerce in connection with the renovated University of London. Much may be hoped from this novel and interesting experiment. *Inter alia* it may have a great effect on schools and other institutions of a lower rank, whose pupils will hereafter graduate in the new Faculty of Commerce. It is one of the offices of a University to show how the higher professions may be aided and quickened, and by setting up a lofty standard of thorough and scientific preparation, to reveal the true relations of academic culture to the qualities which make successful merchants and captains of industry. If this object be attained at the apex of our educational structure in the Universities, the aims of those who control the lower agencies, such as commercial classes in Polytechnics and in secondary schools will become clearer, and the practice of those institutions will be freed from the narrowing influences which have been long associated with the more ignoble type of "commercial academy."

The modest design described in the preface and the title of this volume has, on the whole, been usefully and sensibly attained. Those readers who seek the latest information respecting the ideals of "commercial education" which prevail in America and on the European continent, and the machinery which exists for translating those ideals into practice, will find much to interest them. But those who are trying to make up their minds on the larger problems—What is the place which special knowledge of commercial subjects ought to hold in a scheme of liberal education? How are we to secure that the higher claims of manhood and intelligence shall not be sacrificed prematurely to the lower claims of money-making and "getting on"? and What other studies ought to be pursued concurrently with business training in order to maintain the right balance of character in the future citizen?—must look elsewhere for the help and guidance they desire.

THE BIRDS OF ICELAND.

Manual of the Birds of Iceland. By Henry H. Slater, M.A., F.Z.S. Pp. xxiii + 150; 3 plates and map. (Edinburgh: David Douglas, 1901.) Price 5*s*. net.

MR. Slater has very acceptably filled the want, which many of us have felt, of a handy manual on the birds of Iceland. Much information on the subject is to be found scattered among Icelandic, Danish, German, Latin and English books and periodicals (the bibliography in the present volume comprises more than sixty titles), and this has now been revised and condensed in a compendious, handy form. Added to this we have now the personal observations made by the author in the occasional visits he has paid to Iceland during the last fifteen years, making altogether the most (indeed the only) complete account of the birds of this out-of-the-way corner of Europe which we possess. Without ministering to the insatiable appetite of the egg collector by disclosing the exact breeding localities of the rarer birds, the author has striven to make his manual useful to the many Englishmen who go to Iceland every year for various purposes, and who may take some interest in its birds. Besides reviewing and recommending certain earlier accounts of the ornithology, he names a good guide-book and some maps; and he gives a brief but useful description of the plumage of most of the birds (except those that are common and universally known) and also of the nests and eggs. In the introduction, too, we find some very necessary remarks on the English habit of misspelling and mispronouncing Icelandic words. And following this, and a statement upon the law as to the close-time for birds in Iceland, are three pages of most instructive suggestions on the right pronunciation of the language. All the species on the Icelandic list (one hundred and three, exclusive of eleven the occurrence of which is doubtful, and one, the great auk, which is extinct) are clearly and accurately dealt with in the body of the work; and the native names of the birds, if any, are indicated. The volume is in truth a manual, and its handy size will enable any traveller, however light his baggage, to find room for it.

From its geographical position, far north, and on the extreme west of the Palæarctic region, the avifauna is, as might be expected, a somewhat poor and limited one. It is made up, roughly speaking, of thirty-seven resident species, twenty-seven summer migrants (making sixty-four breeding species, three of which are a little doubtful), twenty-one occasional visitors and eighteen rare stragglers. The resident land-birds number only seven, and the land-birds which come to Iceland in summer to breed only five. The fauna is poorest in Passeres, of which we in England have so many; in Iceland there are only nineteen, eleven of which are only occasional or rare visitors. There are seven birds of prey on the list, two of which are resident and one a summer migrant. The three owls are only visitors. There is one game-bird, viz. the rock ptarmigan. We should add that the author is not responsible for this attempt to analyse the Icelandic avifauna. The great auk at one time resorted to Iceland. Nowadays, perhaps, the northern wren, the great northern diver (a western species, breeding nowhere else in Europe, unless it does so in the north of Scotland), and the Iceland falcon, famous among falconers in old days, are the most interesting birds to be found there. With regard to the wren (which is protected all the year round by law) the author remarks that there can be no reasonable doubt that the great increase of domestic cats in Iceland of recent years is leading very rapidly to its extermination—a fact which bird-protectionists in England would do well to lay to heart. But Iceland is very rich in ducks and geese, sixteen—possibly eighteen—species breeding there. Perhaps from a zoo-geographical point of view Iceland is most interesting as forming a link between the Palæarctic and Nearctic regions. Indeed, the number of birds which are common to the Icelandic and Greenlandic avifaunas, either as regular inhabitants or wanderers, is surprising. The manual, illustrated by three interesting plates and a map, is one of the most acceptable books which have fallen into the hands of the ornithologist for a long time.

OUR BOOK SHELF.

Blütengeheimnisse: Eine Blütenbiologie in Einzelbildern. By Georg Worgitzky. Mit 25 Abbildungen im Text. Buchschmuck von J. V. Cissarz. Pp. x + 134. (Leipzig: Teubner, 1901). Price 3 marks.

THIS title recalls that which was used in 1793 by Christian Konrad Sprengel, and to him the author traces the beginning of the bionomical study of flowers and their fertilisation which forms the subject of the little book before us. Since Sprengel laid the foundations there have been many workers, notably Darwin and Hermann Müller, and many new facts have come to light, while others observed more than a century ago have been rendered more precise. Therefore the author has been led to supply an introduction to the study, simple enough for beginners, and at the same time up-to-date. His method has been to select two dozen common plants, in flower at various times of year from February to October, and to tell the story of their pollination.

Poppy, wild rose, lime, buttercup, forget-me-not, meadow cranesbill and wild radish form the first and simplest group; white dead-nettle, iris, violet, campanula, figwort, cowslip and pink introduce the student to slight complications; broom, spotted orchis, wild carrot, centaury and ling illustrate special adaptations; while flowers pollinated by the wind are exemplified by ribwort, rye, hazel, willow and pine tree. The second part of the book is occupied with a simple discussion of the parts of the flower, the modes of attracting useful visitors, and warding off those that are injurious, dichogamy, self-pollination and kindred topics.

We cannot say that there is either novelty or individuality in Worgitzky's book, but it is clear, accurate, without waste of words, and objective from first to last. The pages are adorned with decorative devices and there are twenty-five simple figures with the amount of enlargement always indicated. Our only grumble is that the author keeps so consistently to the *rôle* of the descriptive naturalist and does not discuss the numerous evolutionist problems which his facts inevitably raise in the inquiring mind. Of course this must have been done deliberately, but we think that the author should have given clearer indication that beyond the floral secrets which he lays bare there lie others not less fascinating, though more mysterious.

The Lepidoptera of the British Islands: a Descriptive Account of the Families, Genera and Species Indigenous to Great Britain and Ireland, their Preparatory States, Habits and Localities. By Charles G. Barrett, F.E.S. Vol. vii. Heterocera, Geometrina. Pp. 335. (London: Lovell Reeve and Co., Ltd., 1901.) Price 12*s*. net; large paper, with coloured plates, 63*s*. net.

AMONG the numerous smaller publications on British Lepidoptera, most of which are useful and interesting in their own way, Mr. Barrett's great work pursues the even tenor of its course, a Triton among minnows, and likely to hold its place as the standard work for the student of British Lepidoptera for many a long day.

The present volume includes the full life-history, as far as is known, of eighty-four species of Geometridæ considered as British, two or three more being incidentally mentioned as European species probably admitted into our British lists by error. These are placed in the three families Boarmidæ, Geometridæ and Acidalidæ, the genus Ephyra being included in the latter family (Ephyra and Hyria being the only genera of the last family included in this volume), while the portion of the Boarmidæ which falls into it includes species formerly classed in Guenée's families Fidonidæ, Ennomidæ, Amphidasidæ, Boarmidæ, Hibernidæ, Zerenidæ and Ligidæ. Guenée's subdivision of the Geometridæ was never accepted in Germany, where the number of families was reduced by many authors to two; and in 1895 Sir George F. Hampson, in vol. iii. of his "Moths of British India," cut down Guenée's numerous families to six, in which he has been followed by many writers since, including Staudinger and Rebel in the catalogue just published. We believe ourselves that, though Guenée may have established more subdivisions than necessary, yet that the modern reaction has gone too far, and that some of his families which have been now abandoned will subsequently be reinstated.

Of the general execution of Mr. Barrett's work we have spoken fully in our notices of previous volumes. The present volume contains detailed notices of several species of considerable interest, such as *Nyssia zonaria*, *Abraxas grossulariata* and *Hibernia defoliata*. Mr. Barrett does not seem to be aware that *Nyssia zonaria*, an insect of our dry coast sand-hills, is said to be found in marshy localities instead, in France. W. F. K.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Testing of some Ballistic Experiments.

WHEN the Council of Military Education directed my attention to the science of ballistics in 1864, I came to the conclusion that a thoroughly good chronograph would solve all practical difficulties. The newly-invented instrument was first tried in 1865 with ten screens 120 feet apart, by the use of a 12-pr. Armstrong B.L. gun, when eleven satisfactory rounds were obtained. (Report (84/B/1941), and (*Proc.* of the R.A. Inst., 1866.) Afterwards Government decided to have systematic experiments made to determine the resistance of the air to ogival headed projectiles ($1{\cdot}5d$) fired from 3, 5, 7 and 9-inch M.L. guns, which were carried out in 1867–68 for velocities 900 to 1700 f.s. The results then obtained are still in use.

In 1871–72 I published general tables, S_v connecting range and velocity, and T_v connecting time and velocity. These tables were adapted to calculate the motion of a projectile when moving in the direction of its axis and acted upon only by the resistance of the air. These tables have now come into general use.

In order to test my first trial experiment of 1865, I will now calculate, by the use of these general tables, S_v and T_v, founded on the results of experiments 1867–68, the time in which the experimental projectile would travel from the first to each succeeding screen, for comparison with the average times determined by the trial experiments, and published 1865–66. Here $w=11{\cdot}5625$ lbs.; $d=3$ inches; $d^2/w=0{\cdot}77838$; $w/d^2=1{\cdot}28472$; $S_v = S_V - sd^2/w = 41261{\cdot}883 - n93{\cdot}406$, where n is to be taken 0, 1, 2 . . . 9 in succession to obtain the velocity at each screen. And $(T_V - T_v)w/d^2$ gives the time in which the velocity of the projectile falls from V to v. (Tables in "Text-book of Gunnery, 1897.")

(α)

Screen.	Exp. time 1866.	Calc. time 1901.	Difference.
	"	"	"
1	0·00000	0·00000	0·00000
2	·10489	·10503	– ·00014
3	·21106	·21121	– ·00015
4	·31845	·31861	– ·00016
5	·42705	·42743	– ·00038
6	·53684	·53714	– ·00030
7	·64780	·64814	– ·00034
8	·75988	·76030	– ·00042
9	·87309	·87361	– ·00052
10	·98831	·98756	+ ·00075

Further, the mean velocity of the projectile, at every 10 feet from the first screen, was calculated from the results of the first trial experiment, and published in the *Proceedings*, 1866. I will now *calculate* the velocity of the projectile at every 100 feet for comparison. Here $S_v = S_V - sd^2/w = 41254{\cdot}1 - n77{\cdot}7838$, where n must be taken in succession 0, 1, 2, &c., to find the velocity at 130, 140, 150, &c., feet from the gun. The following results have been thus obtained:—

(β)

Dist. from gun.	Proceedings, &c. 1866.	Calculated 1901.	Difference.
Feet.	f.s.	f.s.	f.s.
130	1149·4	1149·0	+0·4
140	1148·2	1147·9	+0·3
150	1147·1	1146·7	+0·4
200	1141·3	1141·2	+0·1
300	1130·2	1130·2	0·0
400	1119·4	1119·4	0·0
500	1108·8	1108·9	–0·1
600	1098·7	1098·8	–0·1
700	1089·0	1088·9	+0·1
800	1079·6	1079·5	+0·1
900	1070·5	1070·5	0·0
1000	1061·7	1061·9	–0·2

These two examples (α) and (β), comparing the results of experiment published in 1865–66, and of calculation in 1901, conclusively show the remarkable accuracy

(1) of the trial experiment of 1865,

(2) of the systematic experiments 1867–68,

and (3) of the general tables, 1871, used to connect (1) and (2).

This chronograph was used in all subsequent experiments.

The experiments of 1867–68 were continued by the use of a new 6-inch B.L. Armstrong gun in 1878–79 (Report 84/B/2853), and further with a new 8-inch Armstrong gun in 1880 (Report 84/B/2909). The coefficients of resistance to ogival headed shot ($1{\cdot}5d$) for velocities 100 to 2800 f.s. were thus determined. At an early period it was decided to employ J. Bernoulli's method of calculating trajectories. As opportunity offered, the calculation of auxiliary tables (X), (Y), (T) and (V) was proceeded with, of which 97 pages were published in 1873, and 48 pages in 1881, for the cubic law of resistance. And 70 pages were published in 1890 for the Newtonian law. The ogival form of head ($1{\cdot}5d$) chosen by Government was a very good form for standard experiments, as such projectiles were steadier than more acutely pointed projectiles, and the results obtained were easily adapted to other useful forms by using $\kappa d^2/w$ instead of d^2/w. Thus ogivals ($2d$) were found to encounter a resistance 3 per cent. less than the ogivals ($1{\cdot}5d$), which gives $\kappa=0{\cdot}97$, and I do not remember having had to use any smaller value of κ. I consider that a reduction of 5 per cent., or $\kappa=0{\cdot}95$, would be the least value of κ for projectiles of any practical use.

The only difficulty in experimenting was when the velocity was *low*, for then the trajectories were much curved. But the results obtained were tested by the calculation of 32 rounds of English 6·3-inch Howitzer, and 82 rounds of German 15 cm. Kurze Kanone for velocities 330 to 750 f.s. and found satisfactory. (Final Report, pp. 45–47.) The results for *high* velocities were tested by calculating, by the use of the general tables ($\kappa=1$) the times over given ranges of 1000, 2000, &c., yards, where the elevation of the gun was low, using horizontal muzzle velocities for the 4-inch B.L. 1884; the 6-inch Q.F. 1891; and 1893; the 9·2-inch B.L. 1898; and the 12-inch B.L. gun; for velocities 1000 to 2600 f.s. My coefficients of resistance appeared to be slightly too low. (Second Supplement, p. 15.)

When trajectories are calculated as tests of coefficients, it is necessary that both the calculated range and time of flight agree with experiment. But when an elongated shot was fired with a high velocity, it was found that both the calculated ranges and times of flight were shorter than those given by experiment. If then the resistance was reduced so as to give the desired range, the calculated time of flight was found to be too short. Hence it was clear that the error could not be corrected by any change of coefficient of resistance.

When elongated shot came into use, it was well understood that the projectile would be deflected upwards by the resistance of the air, so as to increase the elevation for which the gun was laid. This was named "kite-like action" in England, and Didion remarked that there would be a considerable deviation of the projectile "tant dans le *plan vertical*, que dans le plan horizontal" (*Traité*, xiii. 1860). Suppose now that the range r and the time of flight t, for an elevation α, have been carefully calculated. Then from the range table of the same gun, corresponding to same range r, find t' the time of flight, and α' the elevation. Then if $t=t'$ the coefficients of resistance giving the required time and range, are correct, and $\alpha-\alpha'$ is due to kite-like action. Thus, using the range table of the 4-inch B.L. gun: $v=1900$ f.s.; $w=25$ lbs.; $\alpha=12°$; and $\kappa=0·97$.

(γ)

	Range.	Time of flight.	Elevation.
Calculation ...	$r=5666$ yards	$t=17''·008$	$\alpha=12°\ 0'$
R. Table ..	$r=5666$,,	$t'=16''·964$	$\alpha'=11°\ 26'$
Difference ...	0	$t-t'=0''·044$	$\alpha-\alpha'=0°\ 34'$

Here for a range of over three miles, the calculated and observed times of flight, from point to point, differ by only $0''·044$, a negligible quantity. The resistance of the air must therefore have increased the elevation, for which the gun was laid, by $\alpha-\alpha'=34'$, due to jump and kite-like action, for an elevation of the gun of 11° 26'. The whole range table of the 4-inch B.L. gun was thus treated in 1892 (NATURE, No. 1190). These calculations have recently been repeated for elevations 7° to 20°, and published in my Second Supplement, where all the leading steps in the calculation of the ranges, &c., have been given. It was then found that when an elevation of 7° is given to the gun, 21' is added to the elevation by kite-like action, so that 7° + 21' must be used for the elevation when it is required to *calculate* the range and time of flight for an elevation 7° of the gun. The elevation of the gun is given in degrees below, and the addition thereto made by kite-like action and jump is given in minutes, 7° + 21', 8° + 23', 9° + 26', 10° + 29', 11° + 33', 12° + 38', 13° + 45', 14° + 53', 15° + 63', 16° + 74', 17° + 86', 18° + 98'.

From the results of calculations of range and time above referred to, I have deduced the following table :—

Range.	Time of Flight.			Elevation.		
Yards.	R.T.	Calculated.	Diff.	R.T.	Calculated.	Diff.
	"	"	"	° '	° '	'
4000	10·49	10·35	−0·14	6 21	6 32	+11
5000	14·30	14·19	−0·11	90 12	9 37	+25
6000	18 40	18·51	+0·11	12 36	13 18	+42
7000	23·50	23·59	+0·09	16 32	17 59	+87

showing clearly that both *range* and *time* of flight—given by *experiment* and *calculation*—agree, when a proper allowance is made for jump and kite-like action.

From the fair application of all these tests, it appears that calculated and experimental ranges and times of flight agree perfectly well for all practical purposes. Hence the laws of resistance determined by me—the general tables published by me—and the adaptation by me of J. Bernoulli's method of calculating trajectories are all quite satisfactory. But care will be required not to make my methods responsible, in any way, for the disturbing effects of jump or of kite-like action. Consequently range tables cannot at present be prepared by calculation alone, but when obtained by experiment, they may be tested at any point by the method (γ) already explained.

This chronograph might be used with great advantage to test the shooting qualities of all big guns. For this purpose the elongated projectiles should be provided with heads of similar forms. The charges used should be such as would give the velocity v, for which the gun is to be tested, near the middle screen. Fire each projectile through the equidistant screens till n satisfactory rounds have been obtained. Calculate K_v', K_v'', &c., for each of these rounds. Then the approximate value of $K_v=\frac{1}{n}(K_v'+K_v''+\&c.)$, and the mean error will be an indication of the steadiness imparted by the gun to its projectile, and so on for any number of guns. The shooting qualities of any guns could be compared for the velocity v, by simply comparing the numerical values of K_v given by each gun—the lower the numerical value of K_v the better the shooting. Target practice might be carried on simultaneously with these screen experiments. The best of the guns taken in South Africa should be brought home and tested in the manner above recommended.

August 1901. F. BASHFORTH.

Horn-feeding Larvæ.

So far back as June, 1898, you published in NATURE a short article from my pen dealing with "Horn-feeding Larvæ"; it opened up the question as to whether the larvæ of the insect *Tinea vastella*, Zell. = *gigantella*, Stn. = *lucidella*, WKr., fed on the horns of living animals. I mentioned at the time that Dr. Fitzgibbon, in 1856, brought home from the Gambia two pairs of horns, one belonging to *Kolus ellipsiprymnus* and the other to *Oreas canna*, which he had purchased from the natives; the horns were perforated by grubs enclosed in cases which projected abundantly from the surface of the horns, the blood at the base of the horns not having thoroughly dried up on them when brought to market.

Dr. Henry Strachan, of Lagos, wrote a letter, dated July 22, 1898, which appeared in NATURE, and in that letter he stated that the living horns were attacked and infested with the larvæ, as cocoons and pupæ had been extracted from such horns within an hour of the killing of the animals owning them. This he states on the unimpeachable authority of an officer who made the observation.

During 1899, 1900, and until July of this year, I have travelled very considerably in West Africa, having spent these years in Northern and Southern Nigeria, as well as Ashanti and the hinterland of the Gold Coast; I have made close observation of many species of horned animals, and have spent many days with native big game hunters. I have seen many cases in which the horns of dead animals have been infested with the larvæ of the *Tineidae*, but have never met with it in those of living animals. The natives with whom I have been associated, who are keen hunters and extremely keen observers, assure me they have never seen any protuberances containing grubs on the horns of living animals. During our campaign in Ashanti, I questioned officers who came with troops from all parts of the West Coast as well as the East Coast of Africa; also some from Uganda and the Lakes: they all unhesitatingly say that they have never seen cocoons on living animals, although well acquainted with them on the horns of dead animals. Dr. Fitzgibbon's statement stood alone until Dr. Strachan's letter appeared. I venture to suggest that the point still remains *sub judice*. W. J. HUME MCCORQUODALE.

August 30.

NEW GARDEN PLANTS: A STUDY IN EVOLUTION.

THE appellation "new garden-plants" is rather puzzling to those who are neither botanists nor gardeners, and, indeed, it is used with somewhat different significations by both these classes of experts. Considering that not the least of the many services rendered by the Royal Gardens, Kew, is the annual publication, as an appendix to the *Kew Bulletin*, of a list of "new garden plants," some explanation of what is meant by this designation may not be without interest. Let us take an illustration. The maidenhair tree, *Ginkgo biloba*, was in reality introduced into our gardens in 1750 or thereabouts. But let us suppose for our present purpose that it was introduced only in this year of grace 1901. Would it in that case have any right to be considered a "new plant"? If we look on it as the direct lineal descendant of a tree that grew in Greenland in Miocene times and had its ancestry still further back in the Oolitic period, we could hardly consider it as "new." The only novelty about it would be its introduction into gardens. Similarly, the Welwitschia, now in cultivation at Kew and elsewhere, was, in garden parlance, a new plant. It was new to Welwitsch when he discovered it in the deserts of Mossamedes in South-West Africa, but nobody looking at the uncouth "monster" would deem it new. Rather would he think of it, as he has a clear right to do in the case of the Ginkgo, as a survival from a prehistoric past. Welwitschia has not, so far as we know, been discovered in a fossil state, but if our Antarctic "discoverers" should light upon its traces near the South Pole, no one would be greatly surprised.

In such cases as these, then, it is the introduction into gardens as cultivated plants that constitutes the novelty. And so it is with the hosts of species of orchids, palms, ferns and other plants with which the zeal of botanists or the enterprise of collectors enriches our gardens. Many of these are absolutely new—new to science, that is, as well as new in gardens. Others are novelties so far as the garden is concerned, but have previously been known to, and duly recorded by, the botanist.

But there is still another category of "new garden plants," and one of such vast interest to the student of evolution that we cannot but express our astonishment that so fertile a field of research has hitherto attracted so few labourers. We allude to new plants actually created in gardens by the skill of the gardener. The materials, no doubt, exist in nature, the gardener does but rearrange them, as the milliner forms "ravishing creations" by tasteful intermixture of tulle and ribbon. But the gardener does more than the milliner. He not only effects kaleidoscopic changes of the same materials, but he sets in operation previously pent-up forces—forces which are made manifest in the phenomena of variation, adaptation and progressive evolution. The modern gardener, by means of incessant vigilance and adjustment of the conditions of environment, so far as he is able to do so, *cultivates* the plants committed to his charge so as to obtain the most healthy foliage, the finest flowers or the most luscious fruit according to his particular requirements. But cultivation is not everything. It improves the old, but it does not create the new. Selection, again, by which the gardener profits much, does not in all cases result in absolute novelty, but only in enhanced quality, a lessened amount of variability and a greater degree of fixity or constancy. A seedsman's "stock" of broccoli, or whatever it may be, is carefully "selected" by the choice and retention of what is required and by the rejection or elimination of what is not desired. The "rogues," that is the plants which do not come up to the high standard of perfection, are ruthlessly destroyed. By these procedures, carried on year by year, the stock at length becomes almost absolutely pure, and, what is more, it is kept so because the tendency to vary has become quiescent. Alter the conditions, exercise less vigilance, variation will again set in and the stock become correspondingly deteriorated. Cultivation, selection and elimination tend to preserve the old rather than to create the new.

Novelty in garden plants, apart from the direct importation of new species from foreign countries, is secured in various ways, such as the conservation or selection of variations which originate naturally. By repeated selection and elimination the desired variation is, as we have just said, finally "fixed." It becomes constant and capable of reproduction by seed. Another method of obtaining novelties is by the observation, retention and propagation of bud-variations or sports. A third and most effectual means is secured by the practice of cross-breeding.

Variation in some degree is almost universal; no two leaves on the same branch are alike, the peas in a pod really contradict the meaning of the proverbial adage, for, instead of being strictly alike, they are more or less different. But the discontinuous variation, the "sport" proper, as it is understood in gardens, is the representative of a more pronounced degree of variation—one that occurs suddenly, or at least its earlier manifestations are so inconspicuous as to be overlooked. It appears simultaneously in widely separated areas. It is mysterious in origin as it is striking in appearance. No doubt in many cases this sporting is a reversion to some ancestral condition, or is due to a separation of previously amalgamated characteristics, but what brings about the separation is a mystery. In any case, the gardener has little or no control over the phenomena of sporting; he does but avail himself of what nature provides him without any effort of his own.

It is a very different thing with cross-breeding. The larger number of "new garden-plants" at the present day are due to intentional cross-pollination or fertilisation. All degrees of this process occur from the union of male and female elements from individuals that present the least degree of distinctiveness up to the combination of the sexual elements in plants so wide apart as to be, for practical purposes at any rate, placed in distinct genera, and in one recorded case in a distinct order. Bigeneric hybrids have been recorded between *Philesia* and *Lapageria* (=Philageria × Mast.), between *Urceolina* and *Eucharis* (=Urceocharis × Mast.), between *Rochea falcata* and *Crassula coccinea* (= Kalorochea × Veitch), *Libonia* and *Sericographis* (= Sericobonia ×), between *Montbretia* and *Tritonia*, between numerous genera of Gesneraceæ, between *Scilla* and *Chionodoxa* (=Chionoscilla ×). Amongst orchids no fewer than 150 bigeneric crosses are recorded (Hurst, in *Journal* of the Royal Horticultural Society, 1900, vol. xxiv. p. 102).

In 1849 Donckelaar, the younger, the curator of the Botanic Garden at Ghent, raised a hybrid out of *Gesnera discolor* by pollen of a Gloxinia. This was called *Gesnera Donckelaariana* by Lemaire in the Jardin Fleuriste (1854), t. iv. p. 382. The good faith of the gardener was needlessly and unjustly impugned, and the hybrid nature of the plant was doubted by Decaisne, as was not unnatural at that time. But now that, as we shall presently see, the gardener has succeeded in actually producing by art the same form that exists in nature, there is no more occasion for scepticism.

Decaisne suggested that Donckelaar's plant was no hybrid, but a new species accidentally introduced with other species of Gesneraceæ. This view received confirmation some years later when Messrs. Veitch received from Colombia a plant which on flowering presented all the characteristics of *Gesnera Donckelaariana*. This plant was figured and described as a species by Sir Joseph Hooker in the *Botanical Magazine*, t. 5070 (1858). Several years afterwards (in 1894) Messrs. Veitch produced a hybrid between *Gesnera pyramidalis* crossed with pollen of Gloxinia "Radiance." This received the name of "Gloxinera ×," and is a sufficient proof that bigeneric hybrids may occur in Gesneraceæ. The Gloxinera was figured and described by Mr. J. Weathers in the *Gardeners' Chronicle* (February 2, 1895), and formed the subject of an interesting note from Count de Kerchove de Denterghem in a subsequent number (February 9, 1895, p. 175).

Many other bigeneric hybrids are recorded among the Gesneraceæ, but, until botanists have agreed as to the limitations and nomenclature of genera in this order (which they are far from having done at present), we must suspend our judgment as to the precise status of the numerous hybrids that are alleged to have been raised. For an account of them up to the time of publication, the reader may be referred to Mr. Burbidge's excellent work on "Cultivated Plants, their Propagation and Improvement" (1877), and to Dr. Focke's "Die Pflanzen Mischlinge" (1881), p. 326 *et seq.*

A still further degree of hybridisation is recorded in Maund's "Botanic Garden" (v. p. 468), where a cross from *Digitalis ambigua* (Scrophulariaceæ) by pollen of *Sinningia speciosa* (Gesneraceæ) is described. This, then, was a biordinal hybrid.

Fertile hybrids, the existence of which was once denied, are now too numerous to admit of further doubt. Mr. Hurst, *l.c.*, cites the occurrence of such plants in ninety distinct genera and only four in which the hybrids are quite infertile. Ninety per cent. of some forms of tuberous Begonias come true from seed, as is recorded in Mr. Lynch's excellent paper on the evolution of plants in the *Journal* of the Royal Horticultural Society (vol. xxv. 1900, p. 24). In that paper numerous illustrations are adduced to show that some garden hybrids, perhaps we might say a large proportion, "come true from seed," that is, the parental characters are reproduced in the progeny as markedly as in the case of any so-called species. Bigeneric hybrids are sometimes equally fertile. For instance, there are two Iridaceous genera, Montbretia and Tritonia, so distinct one from the other that they have always been considered as separate genera. Now the plant called *Montbretia crocosmiaeflora* × by Lemoine was raised by that eminent French gardener between *Tritonia aurea*, which furnished the pollen, and *Montbretia Pottsii* as the female parent. This is what M. E. Lemoine says in the volume to which we have just referred (p. 128):—

"It is generally admitted by all that hybrids are, as a rule, either absolutely barren or at most produce descendants as lacking in number as they are also in vigour and in reproductive qualities. Now *Montbretia crocosmiaeflora* × is a hybrid, and by no means an ordinary hybrid, for it is one of the very small group of bigeneric hybrids, its two parents ranking as species of different genera, and yet it has given birth to a long line of vigorous and fertile plants." This hybrid produces seed naturally, but as the progeny is almost identical with the parent form there is no particular object in the gardener raising such seedlings. But when the flowers of this hybrid are pollinated, by pollen taken from either of the original plants, then modification sets in and these modifications have become fixed (see p. 129).

Chionoscilla ×. The hybrid genus between Chionodoxa and Scilla, which occurs spontaneously when the two plants are grown together, is reported by Hurst to have produced fertile seeds.

Whether the facts that some of the so-called genera not only interbreed but "come true from seed" are to be taken as proofs against their autonomy as separate genera or not is a point of the highest interest, to which we can only allude, but which we cannot here discuss. We must be permitted for our present purpose to set aside theoretical considerations and to look on both species and genera as convenient subdivisions necessitated by the requirements of classification, but which, though probably so, are not yet proven to be phylogenetically "natural." All that we are concerned here to assert is that the gardener has succeeded in producing forms as distinct one from another as, often far more so than, those which we call species, and even genera, and which physiologically as well as morphologically "behave" in the same way that species do.

Tuberous Begonias furnish a case in point. They are no older than, scarcely so old as, the middle of the last century. Their history is perfectly well known. They have grown, as it were, under our very eyes. Were it not so there is no botanist who, seeing them for the first time, but would call them new species and think himself very fortunate in getting new species with such definite and easily recognisable marks of distinction. A distinguished French botanist, the late M. Fournier, even constituted a new genus, Lemoinea, to receive some of these widely divergent forms.

But, some will say, these creations of the gardener's skill are not permanent; alter the conditions and they will disappear. Moreover, they can only be propagated by division and not by seed. Were these objections universally true they would, of course, be fatal to our contention. But they are not universally true, and those that are true are just as applicable to natural species. Some at least, as we have seen, have a high degree of permanence, and many are capable of reproduction from seed.

It must not be supposed that these hybrid productions are all of artificial origin. So far back as 1852, Weddell enumerated, in the *Annales des Sciences Naturelles*, numerous natural bigeneric hybrids, and, of course, hybrids between species are now known to occur frequently among wild plants. But what is very interesting in this connection is the fact that gardeners have, over and over again, demonstrated the hybrid nature of certain wild plants by actually producing them artificially. The younger Reichenbach, from his great knowledge and experience, asserted that several orchids examined by him were of hybrid origin. He arrived at his conclusions solely from the observation of morphological characters. But Veitch and many others have since actually created in their orchid houses, by means of cross fertilising the two species, the same form that occurs in nature. They have proved by demonstration what Reichenbach merely conjectured from appearances. An enumeration of these orchid hybrids that have been produced in gardens is given by Mr. Rolfe in vol. xxiv. of the *Journal* of the Royal Horticultural Society, p. 188. Years before Reichenbach, Dean Herbert came to a similar conclusion as to the hybrid nature of certain Pyrenean narcissi, and he too proved the accuracy of his opinion by producing the hybrid form by artificial means. In our own times, Engelheart is doing the same sort of work and arriving at the same conclusions.

In the last class of cases, the gardeners have, as we have said, succeeded in reproducing the identical form that occurs in nature, and that form, of course, cannot be considered in any sense as a *new* garden-plant. But in the other cases mentioned, such as the Begonias, the Streptocarpus, the Clematis, &c., forms have been produced which have not, and could not have, any counterpart in nature. Some of the Andine Begonias very possibly hybridise naturally because they grow in proximity, or at no very great distance from each other. But what are we to say to the new "race" or "species," as we might term it, produced in gardens by fertilising the descendants of these South American Begonias with one discovered in Socotra by Prof. Bayley Balfour? It is hard to conceive of the possibility of a natural hybrid in this case, but, as artificially produced by the gardener, it is one of the greatest ornaments of our hot-houses and much more distinct from other "species" than most of the South American forms among themselves. It is true that in this case, up to this time, the flowers have been mostly sterile, but there are not wanting indications that the sterility may be naturally replaced by fertility, whilst it is certain that the gardener will discover the means to counteract the present nearly barren condition.

It would be easy to multiply instances wherein the gardener has produced new forms morphologically, and in some cases physiologically, worthy of specific or even of generic rank, but it is unnecessary to cite more, as the fact admits of no dispute. We have alluded to them here for the sake of illustrating one category of "new garden plants."

A point of much practical importance arises with reference to the names that should be given to these garden productions. The Kew list to which we have referred takes the names as they are published in the gardening journals, which in their turn copy them from the labels or the catalogues of the horticulturists. The journals are duly cited in the Kew list, but in no case is the author's name mentioned.

In the majority of instances this is the only course that could be advantageously followed, for the names are generally given without adequate research and with no reference to system. They are, in fact, the outcome of the nomenclator's fancy solely. But in many cases the plant is authoritatively described in the gardening periodicals, and when that is the case the customary citation might with advantage be made in the Kew list.

One most objectionable practice the gardeners have, and that is of imitating the names given by botanists *secundum artem*. In the eyes of the scholar, botanical nomenclature is mostly barbarous, but garden nomenclature is too often ludicrous. It is more than that, it is misleading. A botanist ignorant of the history of a garden plant and finding it provided with a Latin generic and specific name would naturally suppose that he had to deal with a species properly described and recorded, and would waste his time and patience in fruitless search unless by good fortune he lighted on the Kew *Bulletin*.

But if some sort of provisional name could be given to plants of garden origin or to plants of unknown status, such name to be so framed as not to give rise to misapprehension, horticulture would not suffer and science—at least indirectly—would be the gainer.

The Royal Horticultural Society has, at various times, endeavoured to grapple with this evil, and has even formulated a code of rules to be followed by the horticulturists when introducing "new" plants to the notice of the Society or the public. The rules are excellent, but they are far more frequently honoured in the breach than in the observance, and the Society seems powerless to enforce its own precepts even in its own records. The alliance of old custom with new developments, however anomalous, seems likely to persist in the future as it has done in the past. The Kew publications to which we have referred are invaluable to the student by lessening the difficulties of research and neutralising the anomalies of which mention has been made.

THE PHOTOGRAPHIC CHART OF THE HEAVENS.[1]

IT is to be regretted that a whole year has been allowed to intervene between the meeting of the International Committee charged with the construction of the photographic chart of the heavens and the official publication of the proceedings of the members, since the interest that would otherwise attach to the utterances of so many expert astronomers in conference assembled is materially lessened by the delay. Doubtless the collection of proofs from sources so scattered and so distant demands a long time, but the most careful and praiseworthy desire to secure accuracy might have been satisfied with a shorter period. Two very evident drawbacks result from this method of treatment. Not only have more or less complete statements appeared in various scientific journals, but the reports on the amount of progress effected by the various participants in the scheme refer to a twelvemonth since and are already ancient history.

But, on the other hand, it is abundantly evident that these meetings, held from time to time, perform a very useful work wherever widespread cooperation is necessary. They not only afford evidence of the earnestness of purpose and determination to successfully prosecute the scheme, that originated under the auspices of the late Admiral Mouchez, but they supply the means of most readily combining the activities of many observatories to secure a common aim. The readiness with which so many astronomers acceded to the request to undertake the observations of Eros, and the adoption of a uniform plan of wide-reaching extent, could scarcely have been effected in the time at disposal without personal intercourse and mutual encouragement. It is true that the observations have all been made and much of the reduction completed before we get the official report, but this in no way detracts from the value of the results immediately obtained, while the proceedings of the Conference will remain as a valuable historical document bearing on the progress of astronomical science.

To the general methods of observation of Eros and the success which has attended the scheme we have already referred (NATURE, vol. lxiii. p. 502), and may pass the matter aside with the reassuring reflection that the latest reports fully confirm the success that was anticipated from the earlier measures. Of the degree of completeness accomplished in the photographic surveys of the heavens it is not easy to form a very exact notion, owing to no tabular statement accompanying the report and the varied methods of description adopted by the various authorities, but the following table will exhibit fairly accurately the amount of progress reported up to the date of the meeting:—

Limits of Zone in declination	Observatory	Number of plates for catalogue	Number of plates for chart	Number of plates measured
90° to 65°	Greenwich	1106	1076	608
64 ,, 55	Rome (Vatican)	476	106	15
54 ,, 47	Catania	Complete	None	36
46 ,, 40	Helsingfors	Complete	⅓	380
39 ,, 32	Potsdam	Complete	None	(100,000 stars)
31 ,, 25	Oxford	Complete	None	736
24 ,, 18	Paris	Complete	97	650
17 ,, 11	Bordeaux	402	17	293
10 ,, 5	Toulouse	½	45	⅛
4 ,, −2	Algiers	Complete	97	497
−3 ,, −9	San Fernando	Complete	596	145
−10 ,, −16	Tacubaya	746	None	203
−17 ,, −23	Santiago	(Aban	doned)	
−24 ,, −31	La Plata	(Aban	doned)	
−32 ,, −40	Rio	(Aban	doned)	
−41 ,, −51	Cape	Complete	Complete	126
−52 ,, −64	Sydney	Complete	(Greater part)	
−65 ,, −90	Melbourne	900	Complete	

Of the plates for the chart it is intended that there should be two series, made respectively with one exposure of an hour and three exposures of half an hour each. The word "complete" in the chart column is meant to apply to one of these series, but Sir David Gill has made considerable progress with the second series. The arrangements made for supplying the lacunæ caused by the South American observatories finding themselves unable to fulfil their engagements have already been reported (p. 335).

To judge from the number of papers presented on the determination of photographic magnitude, this subject still seems to occupy a large share of the attention of the Committee—larger, indeed, than to an outsider the subject seems to warrant. On the occasion of the meeting in 1896, the committee decided that the several observatories were at liberty to determine the photographic magnitude, either by estimation or by measurement, simply stipulating that whatever system was adopted it should be one capable of precise definition and permit

[1] "Réunion du Comité international permanent pour l'exécution de la Carte photographique du ciel, tenue à l'Observatoire de Paris en 1900." (Paris: Gauthier-Villars, 1900.)

the scales adopted to be reduced to a common system. This seems to give sufficient latitude, but, nevertheless, at the eleventh hour, no less than five different papers are presented on this vexed question of magnitude. Among other papers forming the annexe is a short but interesting note from the Astronomer Royal on the number of stars found on each of the plates devoted to photographing the Polar Cap, with a comparison with the numbers comprised in the Durchmusterung and the accurate catalogues of the Astronomische Gesellschaft. The totals are as follows :—

Number of stars measured on the plates	58,176
Number of stars to the square degree	70·0
Number of stars in Argelander's Durchmusterung	9979
Ratio of photographed stars to Bonn D.M. ...	5·83
Number of stars in A.G.C. Catalogues	4966
Ratio of photographed stars to A.G.C.	11·7

If the number of stars approximately increases as the magnitude diminishes, the ratio here given would point to the faintest stars on the plate being 1·9 mag. fainter than Argelander's faintest stars, or well covering the eleventh magnitude, originally assigned as the limit to which the catalogue should extend.

Since writing the above, M. Lœwy has published very complete details showing the approximate times of observation of the planet Eros at no less than forty-six observatories where the work has been undertaken. The energy displayed is of the most gratifying character, and the final result will no doubt demand a degree of confidence commensurate with the labour that has been bestowed on the undertaking. The work is shown to be one of gigantic magnitude, and M. Lœwy displays considerable hopefulness in suggesting that two years may see it completed. Several other papers, all devoted to securing accuracy and homogeneity in the final reductions, also appear in this brochure. We may especially call attention to a paper by the Director of the Paris Observatory on the degree of precision that the photographic measures possess, and of the success that is likely to attend the adoption of the scheme for driving the equatorial at various rates depending on the amount of geocentric motion of the planet itself. The additional matter supplied by the Paris authorities is of a highly interesting character to which we hope to do justice later, when complete details from the various authorities are published.

THE COLORADO POTATO BEETLE.

THE official announcement by the Board of Agriculture of the appearance of the Colorado potato beetle swarming in a potato field at Tilbury is a very serious matter, for we have no wish to see another insect pest added to those with which our agriculturists already have to contend. It is satisfactory to know that the Board took instant measures to cause the destruction of all the crops within the infested area ; and as the surrounding neighbourhood has since been searched in vain for any further traces of the insect, it is confidently hoped that the measures taken for its timely extirpation have proved successful.

The beetle is about half an inch long, and slightly oval in form. The wing-cases are longitudinally and alternately striped with black and yellow, and the wings are red. The grubs, which feed on a great number of other wild and cultivated plants besides the potato, are orange or reddish, with a row of black spots on each side. The oval yellow eggs are laid in clusters.

The insect was so destructive in North America some years ago that great fears were entertained of its spreading to Europe ; and at that time was passed the Destructive Insects Act, according to which every person meeting with the insect is bound, under a penalty of 10*l*., at once to inform the police, who in their turn must notify the local authorities, who must communicate by telegraph with the Board of Agriculture.

It must be remembered that, if there is danger of an injurious insect establishing itself in a country, instant action is as necessary as in the case of a threatened epidemic.

W. F. KIRBY.

PROF. BARON ADOLF ERIK VON NORDENSKJÖLD.

WHEN a man who has spent an earnest and useful life reaches the mature age of threescore years and ten, it must be a relief to those near and dear to him when his last days are not spent in suffering. The great Swedish explorer's end was in this wise. "His death," writes his nephew, Dr. Otto Nordenskjöld, "was absolutely sudden ; the same day he was working in his laboratory, occupied with great plans in his mineralogical and chemical work."

Baron Adolf Erik von Nordenskjöld was born at Helsingfors, the capital of Finland, on November 18, 1832, the third in order of seven children. His father, Nils Gustav Nordenskjöld, descended from a scientific family, and, himself an ardent naturalist, was chief of the Mining Department of Finland. Nils Gustav was a most distinguished mineralogist, and his work brought him into communication with the most eminent mineralogists and chemists of his time in France, Germany, and Britain. He travelled as far as the Urals, and on many of his journeys he was accompanied by his son, Adolf Erik von Nordenskjöld, who as a boy became an industrious collector of minerals and insects. He acquired great skill in collecting minerals and in the use of the blow-pipe, which his father handled with a masterly skill, unknown to most of the chemists of the present day. Thus, both by inheritance and by the influence of environment, Nordenskjöld had opportunities allotted only to the few, but which were taken the greatest possible advantage of. His early education was from private tuition, after which he was sent to "gymnasium" at Borgo, a connecting-link between school and university. Here he distinguished himself, as the rector expressed it, "only by absolute idleness." He was marked in his certificate "unsatisfactory" in nearly the whole of the subjects. His parents were judicious enough not to attach any importance to this well-deserved mishap. His private tutor was removed ; and with five silver roubles Nordenskjöld had to seek modest board and lodging, and got full liberty to manage his studies in his own way. "Self-respect," he says, "was thus awakened. I became exceedingly industrious, and was soon one of those then attending the gymnasium who obtained the best reports."

Nordenskjöld entered the University of Helsingfors in 1849, devoting himself chiefly to the study of chemistry, natural history, mathematics, physics, and, above all, of mineralogy and geology. He took charge of the rich mineral collection of Feugard, and made many excursions. In 1853 he accompanied his father on a mineralogical tour to Ural, when he planned an expedition to Siberia, which the Crimean War prevented him from carrying out. On his return he wrote, as his dissertation for the degree of licentiate, a paper "On the Crystalline Forms of Graphite and Chondrodite," which was discussed under the presidency of Prof. Arppe on February 28, 1855. At this time he published "A Description of Minerals found in Finland," "The Mollusca of Finland" with Dr. E. Nylander, and shorter papers in the "Acta Societatis Scientiarum Fenniæ." During this time he was appointed Curator of the Mathematico-Physical Faculty and to a post at the Mining Office with inconsiderable pay. Before he received his second quarter's salary he was removed from these offices at the instigation of the Governor-General, Count von Berg. This was done on account of some political speeches of a frolicsome nature made at a tavern in Thölö. Some of the students were rusticated for a term, and Nordenskjöld got double dismissal without further ceremony. He bore his misfortune with philosophic calmness, and betaking himself to Berlin worked in Rose's laboratory at mineral analysis.

Next year he returned to Finland, and received the Alexander stipend for a tour of study through Europe, and obtained his degree of master and doctor. At this "graduation" ceremony the Universities of Upsala and Lund had a deputation that was received in a most cordial manner, and Nordenskjöld proposed a toast "to our memories all, and to the time that has been and the time that shall come, if only it does not bring Finland's fall, a toast to the days of memory that have fled and the hope that still remains." This speech the tyrannical von Berg regarded practically as high treason. Nordenskjöld treated the whole affair with contempt, but had to leave Finland and go to Sweden. The Russian Government, moreover, deprived him of the right of ever holding office in Helsingfors University. Further persecution followed, and von Berg actually urged in the Senate, Nordenskjöld's exile for having entered foreign service without asking permission of the Russian Government. After 1862, however, when von Berg's term of office had expired, he was allowed to go to Finland whenever he pleased.

Nordenskjöld's first visit to the Polar regions was with Torell to Spitsbergen in 1858, with whom he went as geologist. At Belle Sound he found Tertiary fossil plants which formed the first of the extensive geological collections brought home by subsequent Swedish expeditions; besides these he also obtained fossils from the Carboniferous and Jurassic formations, as well as fine minerals from the limestone veins on the Norways, Cloven Cliff, &c. On the death of Mosander, after his return, he was appointed professor and director of the Riks-Museum, Stockholm. It was because he held this post that von Berg wished to have him declared an exile. By means of energetically purchasing and collecting, and in consequence of the extraordinary richness of the Scandinavian peninsula in rare and remarkable minerals, the Mineralogical Museum at Stockholm, with help of the collections, valuable in certain directions, which have existed from Mosander's time, has in this way become one of the most considerable in Europe. In 1860 his old friend J. J. Chydenius, afterwards professor of chemistry at Helsingfors, joined him as collaborateur, and they made many excursions together. In 1860 his mother died, but he was not permitted to visit Finland even to bid her a last farewell. In 1861 he again visited Spitsbergen with Torell, on which occasion he had an opportunity of surveying the northern part of that archipelago, clearing up the main points of the geognosy of the country. This expedition was the first foundation of a true knowledge of the natural history of the Polar countries. In July 1863 he married Anna Mannerheim, a Finnish lady, and abandoned all thoughts of further Arctic journeys. "Circumstances, however," he says, "so arranged themselves that just from this time they were resumed by me, and on a greater scale than before." In 1863 he was asked by the Royal Academy of Sciences of Sweden to lead an expedition to Spitsbergen in the place of K. Chydenius, who was ill. He asked Docent Duner and Dr. Malmgren, of Lund, to join him. Starting in the spring of 1864, he completed the preliminary part of the survey for the arc of meridian, mapped the southern part of Spitsbergen, and collected new data as to fauna and flora. The sea was very free of ice; but an attempt at a high latitude was frustrated by meeting with seven boats with the crews of three wrecked walrus sloops, which compelled immediate return to Norway. In 1867 he visited Paris, having been commissioned, along with Prof. A. P. Ångström, to compare a normal metre and a normal kilogram, which had been made for the Swedish Government, with the prototypes preserved in the Conservatoire des Arts et Métiers.

Through Count Ehrensvard, Governor of Gothenburg, funds were raised, after several unsuccessful attempts, from Dickson, Ekman, Carnegie, &c., for another Polar expedition. State-Counsellor Count Platen, head of the Marine Department, took a special interest in the plan, and the iron steamer *Sofia* was placed at Nordenskjöld's disposal by the Government. On September 19, 1868, the *Sofia* attained the highest northern latitude which any vessel can be proved to have attained in the old hemisphere—namely, 81° 42′ N. The name of Mr. Oscar Dickson is always associated with that of Nordenskjöld; it was he who had contributed most liberally to the expedition of 1868, and Nordenskjöld was overjoyed when he voluntarily offered to equip another expedition to the same region. It was determined that the new expedition should have for its object to winter on the north-east coast of Spitsbergen, in order thence to push northwards in sledges on the ice. After a long set of inquiries as to whether dogs or reindeer should be used for draught purposes, Nordenskjöld decided upon reindeer. It was also decided, with Mr. Dickson's consent, that Nordenskjöld should go to Greenland to investigate the question of dogs, and this expedition was extended into a scientific one, three young Swedish men of science accompanying him. On this occasion he made a long journey into the interior of Greenland, almost equal in distance to that of Nansen undertaken some years later. Of this journey Nordenskjöld says: "I had here an opportunity of clearing up the nature of a formation which, during one of the latest geological ages, covered a great part of the civilised countries of Europe, and which, though it has given occasion to an exceedingly comprehensive literature in all cultivated languages, *had never before been examined by any geologist*." The same year, with some others, Nordenskjöld petitioned the Swedish Government to form a colony in Spitsbergen to work its mineral resources. This petition gave occasion for the Foreign Minister of Sweden to inquire of the Powers of Europe as to the annexation of Spitsbergen by Sweden. Russia alone objected, and Spitsbergen remains to the present day "No Man's Land."

The long-prepared new Polar expedition finally started in 1872. "The state of ice," says Nordenskjöld, "on the north coast of Spitsbergen was more unfavourable in 1872 than it had been at any time since the coast was frequented by the Norwegians." The reindeer escaped on the third day. The ship got frozen in on September 29, and the crews of six walrus sloops, which had also been frozen in, depended on Nordenskjöld for subsistence. Thus Nordenskjöld, instead of having twenty-four mouths to feed, was confronted with the almost insuperable problem of feeding 125. Seventeen of the walrus hunters, therefore, under the veteran Mathilas, reached Cape Thorsdem by boat, 200 miles distant, where they found all necessities at the quarters of the Swedish colony. Fortunately, two vessels escaped in November and took the crews of four vessels with them; but two men who remained died that winter. Nothwithstanding all this, the expedition yielded important scientific results, not the least important being the discovery of cosmic dust on the Polar ice. Extensive journeys along the north coast and across the inland ice of North-east Land were also made. In spite of the heavy expenses incurred in this voyage, Mr. Oscar Dickson declared that he was willing to "go on."

During the next few years, with his help, Nordenskjöld worked at the opening up of the Yenisei and the Siberian seas, which culminated in his ever-memorable voyage, accomplishing the North-east Passage in 1878–79. The voyage of the *Vega* is still fresh in the minds of all. Leaving Tromsö on July 21, she rounded East Cape on July 18, 1879, less than twelve months afterwards. The *Vega* found the Kara Sea free; and since that sea was so favourable, a considerable time was spent on dredging, sounding, and other scientific observations, including the re-mapping of the coast-line between Yenisei and Cape Sterlegof. Ice and bad weather detained him at Tainia Bay, but on August 19, the *Vega* rounded the northernmost point of Asia, Cape Chelyuskin. Next day the *Vega* was further north, namely, 77° 45′ N., which proved to be the most northerly point reached. At the Lena Delta, the *Lena*, which accompanied the *Vega* so far, turned southward up the river, and Nordenskjöld continued his voyage toward Bering Strait. On September 12, progress was stopped at the "North Cape" of Cook, where he turned back to Bering Straits in 1778, and Nordenskjöld was forced to winter off Pitlekai in 67° 07′ N., 123° E. Systematic scientific observations were carried on during the whole winter, spring, and following summer, till on July 19 they were released, and two days later rounded the eastern extremity of Asia with flying colours. On September 2, 1879, Nordenskjöld dropped anchor at Yokohama, whence the whole civilised world received the news that this man had accomplished what had so often been attempted during three centuries. For this brilliant exploit, Nordenskjöld was awarded a magnificent reception throughout Europe, and many honours were showered upon him, including his elevation to the rank of Baron in the Swedish Peerage. It is from the complete and striking success of this expedition that Nordenskjöld became popularly world-renowned.

In 1883 he undertook a second expedition to Greenland, penetrating further into the interior than any other explorer.

His success rested on the solid basis of his scientific instinct and training, and of his indomitable will and courage. It is to him that we owe the first real efforts at undertaking scientific research in the Polar regions, especially from the geological and mineralogical aspects.

His researches outside the Polar regions were also important. He discovered uranium in many varieties of coal, and he showed that fresh water could be obtained anywhere in Scandinavia at a depth of 100 feet through the Archæan rocks. This has been proved in 400 cases to be correct, and has been of great advantage to pilots, fishermen, lighthouse keepers, &c., living on small islands without water, and also for many factories. He remained a politician all his life. On account of refusing to suppress his opinions in this direction, he was rejected in 1867 as a candidate for the chair of mineralogy and geology in Helsingfors University, although he was unanimously recommended. As the son of a Swedish nobleman, he sat and voted in the Swedish House of Nobles; but, although so intimately associated with Sweden for the greater part of his life, he always referred to Finland as his "dear Fatherland." In his latter days he interested himself in South Polar exploration, and it must have been pleasing to him to know that his nephew was about to lead an expedition to the Antarctic regions.

W. S. BRUCE.

NOTES.

THE appointment of the Royal Commission on Tuberculosis was announced in Tuesday's *Gazette*. The Commission is composed of Sir Michael Foster, K.C.B., F.R.S., Prof. G. S. Woodhead, Prof. S. H. C. Martin, Prof. J. McFadyean, and Prof. R. W. Boyce. It is appointed to inquire and report with respect to tuberculosis:—(1) Whether the disease in animals and man is one and the same; (2) whether animals and man can be reciprocally infected with it; and (3) under what conditions, if at all, the transmission of the disease from animals to man takes place, and what are the circumstances favourable or unfavourable to such transmission.

THE International Engineering Congress was opened at Glasgow on Tuesday with an address by the president, Mr. James Mansergh, F.R.S. Referring to the value of the work of settling standard sections of important constructive materials, Mr. Mansergh remarked that this matter had been taken in hand by a joint committee of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Iron and Steel Institute. Sir Benjamin Baker, with a specially-selected sub-committee, had charge of bridge and general building construction; Sir John Barry, with similar assistance, of railways; Mr. Denny, of shipbuilding; and Sir Douglas Fox, of rolling-stock. In the hands of these eminent engineers the work would be well handled. The address concluded with brief references to some of the chief subjects to be brought before the various sections of the congress. After the address members of the congress dispersed to the meeting rooms of their sections, where addresses were delivered by the sectional presidents, and papers were read.

THE forty-sixth general meeting of the German Geological Society will be held at Halle on October 4–7.

WE regret to announce that Dr. Charles Meldrum, C.M.G., F.R.S., late Director of the Royal Alfred Observatory, Mauritius, died on August 28 in his 80th year.

IT is stated that the exhibits of the German chemical industry at the Paris Exposition valued at 30,000*l.* have been presented to the Technological Institute of the University of Berlin.

THE Vienna correspondent of the *Times* states that the Emperor Francis Joseph has addressed an exceptionally cordial autograph letter to Prof. Edward Suess, the eminent Austrian geologist and politician, on his retirement from the Vienna University. The Emperor expresses his high appreciation of the work done by Prof. Suess in science, as an academic teacher, and as a public man, especially in the promotion of sanitary reform.

A TELEGRAM received by the American Consul at Christiania from the secretary of Mr. Baldwin's American Polar Expedition at Hammerfest, states that the Norwegian steamship *Frithjof*, which is one of the vessels employed by Mr. Baldwin, has returned to Hammerfest after fitting out and provisioning the expedition in Franz Josef Land. The expedition was landed at Cape Ziegler; when the *Frithjof* sailed from that point the conditions were favourable for pressing northwards, and Mr. Baldwin intended to begin his advance the next day.

THE Australasian Ornithologists' Union has been successfully inaugurated, and the first general meeting will be held at Adelaide in October or November. The objects of the Society are "the advancement and popularisation of the science of ornithology, the protection of useful and ornamental avifauna, and the editing and publication of a magazine or periodical, to be called *The Emu*, or such magazine or periodical as the Society may from time to time determine upon." Colonel W. V. Legge is the president-elect, and Mr. D. Le Souëf, Zoological Gardens, Melbourne, is the honorary secretary.

IN connection with the proposed Pasteur statue for Paris, the Paris correspondent of the *Chemist and Druggist* states that an attempt is being made to make it a national monument. The idea is that every Frenchman and resident in France should become a subscriber, and amounts from a halfpenny upwards will be received. Subscription-lists have been distributed in large numbers amongst heads of business-houses, manufactories, and Government offices, inviting them to collect sums, however small.

THE New York correspondent of the *Times* reports as follows upon experiments made at Havana to test whether yellow fever is carried by mosquitoes:—"Out of eight persons bitten by infected insects three have died, three have the fever and will possibly recover, one is not affected, while as regards the remaining case it is too early to make a diagnosis. The physicians are shocked at the result of the experiments. It was supposed that direct infection from mosquitoes caused only a mild form of the disease, and was a safe means of making the subjects immune. It is now definitely known that a man bitten by an infected mosquito after being inoculated with the serum introduced by Dr. Caldas, a Brazilian expert, has developed a genuine case of fever."

MAJOR RONALD ROSS, F.R.S., has just returned to England rom West Africa, where he has been organising a campaign against mosquitoes and malaria. After inaugurating the campaign at Sierra Leone, Major Ross went to Lagos, where the Government actively concerns itself with all matters affecting the health of the community. In welcoming him to the colony, the Governor, Sir William Macgregor, referred to the measures taken to promote sanitary conditions, and thus increase the industrial prosperity of West Africa. Major Ross, in thanking His Excellency, said that he had been on the point of believing that his countrymen were becoming an unscientific and unpractical people. More than two years ago the fact that malarial infection is communicated by mosquitoes had been established by the most stringent scientific and experimental proof; and yet to his knowledge practically nothing had been done by his countrymen to act on this new information, in spite of its economic importance. He had, therefore, accepted with alacrity the offer of a large sum of money and other facilities from a generous philanthropist, and from Mr. A. L. Jones, Mr. John Holt, and others in England, to pay the expenses of practical work against malaria in Sierra Leone. This work had been commenced with every promise of success by his friend, Dr. Logan Taylor, and he had, therefore, felt himself free to proceed to Lagos to watch the work being done there. He was delighted to find that his pessimistic attitude was not justifiable as regards Lagos. He strongly eulogised everything that was being done against malaria by Sir William MacGregor, himself a distinguished member of the medical profession, by his most able friend, Dr. Henry Strachan, and by the enlightened medical profession and the Ladies' League in Lagos. He had witnessed the rapid and successful filling up of marshes by sand from the lagoons, and the rational utilisation of gaol prisoners for this useful work. He had inspected numerous houses rendered mosquito-proof by fine wire netting, which, while it did not exclude the breeze, as he expected it would, did exclude insects and damp, much to the comfort of the inmates. He highly commended the efforts of the Government to induce their officials and others to take quinine—a prophylactic which was much neglected in consequence of ignorance and faddism. Before the departure of Major Ross for Accra, Mr. C. Tambaci and other leading merchants promised to place an annual subscription of 150*l.* in the hands of the Governor to pay for a "Mosquito Brigade" for Lagos.

IN an address on tuberculosis given at the autumnal conference of the Sanitary Inspectors' Association last week, Sir James Crichton Browne referred to the subject of the relation between bovine and human tuberculosis, and Dr. Koch's recent statements upon it. In the course of his remarks, he said:—"Private investigations and experiments, laudable and significant enough though they might be, would not meet the requirements of the case, and the country was entitled to ask that a thoroughly competent public tribunal should, after a searching trial, determine whether the restrictions on trade that had been proved to be unnecessary should be abolished, or whether still more stringent restrictions than hitherto should be enforced to prevent human tubercular infection from animal sources. Dr. Koch had discredited the Report of the last Royal Commission on Tuberculosis, which up to now they had regarded as a standard work of reference; and it seemed highly desirable that the Report should be officially confirmed or declared to be obsolete." It was afterwards unanimously resolved:—"That this Association is of opinion that it is desirable that a Government inquiry should be instituted into the question as to the identity or the non-identity of human and bovine tubercle, and that a copy of this resolution be sent to the Right Hon. Walter Long, President of the Local Government Board."

READERS of NATURE are aware that kites carrying meteorological instruments have been employed for several years at the Blue Hill Observatory, Massachusetts, in the studies of the atmosphere carried on there. Until recently, no flights were made in winds having rates of less than twelve miles an hour; but Mr. A. L. Rotch, the Director of the Observatory, has now used the common method of creating an artificial wind and raising kites in comparatively calm weather by motion of the earth-end of the kite string or wire, the motion in this case being obtained from a rapidly moving tug. The apparatus employed consisted of a portable windlass containing 3600 feet of wire, three Hargrave kites having a total lifting surface of 80 square feet, and an instrument for recording temperature, pressure and wind velocity and humidity. This outfit was installed on the upper deck of a tug in Massachusetts Bay on August 22. Two flights were made, and the greatest heights reached were 2630 and 2670 feet. With more wire and kites much greater heights could have been obtained. The natural wind varied between six and eleven miles an hour, and was much too light to elevate the kites and apparatus, but by steaming against the wind the velocity relative to the tug and kites was increased to between fourteen and nineteen miles an hour. In this artificial wind the kites rose easily, and so steadily that they could be let out from and hauled into hand without the slightest risk to kites or instruments. The kites were very sensitive to alterations of the course of the tug, and began to fall whenever the course varied 30° to 50° on either side of the mean direction of the wind. The experiment shows that meteorological records at great heights may easily be obtained during calms or very light winds by means of kites flown from a rapidly moving steamer; and that it is now possible for the observer and student to work uninterruptedly under almost all conditions of wind and weather.

THE Kew *Bulletin of Miscellaneous Information* for November and December 1899 has just been received. In spite of its belated publication, several of the contributions to it are noteworthy. Of current interest is a paper on the two West Australian woods, jarrah (*Eucalyptus marginata*) and karri (*Eucalyptus diversicolor*), which are now largely used, especially for wood paving. Over nearly all the world, and more particularly in England, these woods are in increasing demand. A Department of Woods and Forests has now been established, and its general usefulness as regards the control and management of the enormous natural wealth of the timber resources of the colony is beginning to be recognised and appreciated. Something over one million acres of forest land have now been leased from the Government for the purpose of acquiring the timber upon them. This is chiefly jarrah country, and embraces some of the finest forests of that particular kind of tree, which is the principal timber-tree in Western Australia. There are other timbers in the forests which are equally, if not more, valuable for their own special purposes, but for general constructive works, necessitating contact with soil and water, the timber of this tree stands foremost. The karri is not so well known as the jarrah owing to the limited area and, at present, comparative inaccessibility of its field of growth. It is the giant tree of Western Australia, if not of the whole Australian continent. For street blocking karri timber is most valuable, and for this purpose seems to be equal to, if not better than, the jarrah, in that its surface, by the wear caused by the traffic, does not render it so slippery for the horses' feet. As is well known, this timber is now largely used for London street paving.

SOME farmers believe that the moon has a direct effect upon vegetation, and that the time of sowing seeds should be regulated by the lunar phases. No accurate experiments appear to have been made to investigate this influence; and a note in the U.S. *Monthly Weather Review* points out that the belief is one that has come down to us from very early times, and began before accurate observations were recorded. Two proverbs relating to the influence of the moon upon vegetation, as handed down to us through folk-lore, read as follows:—

> "Go plant the bean when the moon is light,
> And you will find that this is right;
> Plant the potatoes when the moon is dark,
> And to this line you will hark."
> (*Dunwoody, Weather Proverbs.*)
>
> "Sowe peason and beans in the wane of the moone
> Who soweth them sooner, he soweth too soone."
> (*Werenfels, Dissertation upon Superstition*, 1748.)

Here are two different sayings as to the phase of the moon during which to plant: (1) a bright moon for beans and a dark moon for potatoes; (2) a waning moon for peas and beans. Another proverb states that sowings should always be made at the period of an increasing moon. Further astrological considerations are also often introduced, and if they were permitted to determine the time of planting seeds, farmers would find that there are only one or two full working days in a whole month when the moon and the signs are favourable. Fortunately, farmers as a class wisely busy themselves with seed-sowing when the soil (not when the moon) allows it, and have more faith in laborious cultivation, manure, rainfall and temperature than in lunar influence.

MR. J. HALL-EDWARDS, who was surgeon-radiographer to the Imperial Yeomanry Hospital, South Africa, described some of his experiences as to the value of Röntgen rays in warfare at the recent meeting of the British Medical Association. He found that the plan of obtaining the current for charging the accumulators from a dynamo connected with a belt to a foot motor of the bicycle type was altogether impracticable, as no one could work the bicycle arrangement long enough to be of much use. A small oil engine was used instead of the foot power, and worked very satisfactorily. As to the results of the introduction of Röntgen rays into military surgery, Mr. Hall-Edwards remarks:—"With the friendly aid of these rays, we are enabled to record the effects of small-bore projectiles under the various conditions which occur in actual warfare. We are enabled to localise the position of a bullet or other foreign body with absolutely scientific accuracy; and, if our present knowledge be used to its fullest extent, we can see the condition of the parts as plainly as we could do were the soft tissues composed only of transparent gelatine. These facts being recognised, it is easy to see that the application of the rays to military surgery must produce results of the greatest possible value for future guidance, and that their complete application in a great war—such as we are at present engaged in—must prove of inestimable service in increasing our knowledge upon this most important subject. Many of the time-worn, useless and dangerous methods of finding the whereabouts of hidden bullets may now be forgotten; for with these rays we have at our disposal an aseptic, scientific and absolutely accurate method of localisation, which may be improved, but which even now is as near perfection as our present knowledge can make it. There can be little doubt that, in the face of the new facts brought to light by means of these rays, military surgery will have to be rewritten, and the advance made will mark an epoch in its progress."

"I RETURNED, and saw under the sun, that the race is not to the swift, nor the battle to the strong," wrote the wise man. Writing in the same prophetic vein, M. J. de Bloch in the current *Contemporary Review*, and Mr. H. G. Wells in the *Fortnightly* for September, depict in graphic colours the transformation which the immediate future will witness in the methods of warfare. Both writers are convinced that the military tactics of the past are irretrievably dead. The effective soldier of the future will be a man whose capacity for individual action has been cultivated and developed. The day for all the picturesque accompaniments of war is done, and exhibitions of mere brute courage will be of no avail. Mr. Wells takes into account the resources which modern science has made available for the business of war, and proceeds to anticipate the most likely directions that future advances will take. Of one thing he leaves his reader in no doubt, victory is bound to be with the nation that most sedulously attends to the education of its people in the scientific method. The great war of the future will be fought by citizens familiar with destructive instruments of precision, who have learnt to utilise all the accessory helps which science is gradually perfecting. There will be few professional military men of the type of to-day in the ranks of the victorious nation. In Mr. Wells's words, "the warfare of the coming time will really be won in schools and colleges and universities, wherever men write and read and talk together. The nation that produces, in the near future, the largest proportional development of educated and intelligent engineers and agriculturists, of doctors, schoolmasters, professional soldiers, and intellectually active people of all sorts; the nation that most resolutely picks over, educates, sterilises, exports, or poisons its People of the Abyss; . . . the nation in a word, that turns the greatest proportion of its irresponsible adiposity into social muscle, will certainly be the nation that will be the most powerful in warfare as in peace."

WE have received a report by Prof. Elster on progress in the study of Becquerel rays, reprinted from Dr. Eder's photographic *Jahrbuch* for 1901. It is a summary of experimental work done in this direction subsequent to the report by the same author for the previous year.

A REPRINT from the *Proceedings* of the South London Entomological Society contains a paper on the ova of Lepidoptera, by Mr. F. Noad Clark. Mr. Clark has been highly successful in photographing these eggs, especially when account is taken of the difficulty of obtaining good photographs of opaque microscopic objects.

FROM the annual *Report* for 1900 we learn that the Botanical Exchange Club of the British Isles now has a membership of fifty. During the year 373 covers were sent in, 67 containing Rubi, 49 Hieracea, and 14 Euphrasiæ, the total number of specimens received and distributed being 4575. The report contains a large number of notes of new varieties, new localities, and records confirming the persistence of rare species and varieties in previously recorded habitats.

A THESIS recently presented to the Paris Faculty of Science by M. Henri Bénard deals with the cellular distribution of eddies produced in liquid films when convection currents are set up. Although the phenomena herein described have been previously recorded, but little appears to have been done in submitting them to systematic observation. These phenomena consist in the property that when a horizontal film of liquid has its lower surface heated to a higher temperature than its upper surface, the convection currents divide the liquid into a series of more or less regularly formed hexagonal cells, the liquid flowing down the sides and up the middle. The experiments have been made chiefly with spermaceti, various methods being adopted in order to make the cellular structure visible by the addition of solid particles. The distribution of motion is found to be permanent and stable, and M. Bénard has determined all the geometric, kinematic and dynamic elements of the motion.

Bulletin No. 44 of the Agricultural Department of Madras consists of notes on the domesticated cattle of that Presidency by Mr. J. D. E. Holmes, of the Veterinary Department. The various breeds found in this part of India are recorded and briefly characterised.

A RECENT issue of the *Proceedings* of the U.S. Museum (No. 1228) is devoted to the consideration of the relationships of the jumping-mice to the jerboas on the one hand and to Sminthus on the other. The author, Mr. M. W. Lyon, comes to the conclusion that the first-named animals typify a family (Zapodidæ) by themselves, and that in that family should be included the genus Sminthus, which was referred by Alston to the mice and rats (Muridæ). In No. 1227 of the same publication Mr. D. W. Coquillett discusses the classification of the flies (Diptera).

THE first part of a list of the birds in the Indian Museum, Calcutta, by Mr. F. Finn, has been received. Although this little work is nothing more than a classified list of species (containing in this part the families Corvidæ, Paradiseidæ, Ptilonorhynchidæ, and Crateropodidæ), with a record of the specimens by which each is represented in the Calcutta Museum, it has a considerable value to ornithologists on account of the inclusion of a list of "type" specimens. How extensive must be the series of such types in the Indian Museum may be inferred from the fact that there are no less than sixty-six in the Corvidæ and Crateropodidæ alone. Bearing in mind the liability to damage and decay of almost all natural history specimens in the climate of Lower Bengal, the question must suggest itself to all ornithologists whether it is advisable that such valuable specimens should remain permanently in Calcutta.

OUR American contemporary *Science*, for August 16, contains the report of a lecture on regeneration and liability to injury in animals, delivered by Prof. T. H. Morgan at Columbia University. In this lecture (which forms the first of a series) Prof. Morgan commences by discussing the common belief as to the existence of a definite relation between the liability of an animal to injury and its power of regeneration, and the idea that those parts of an animal most subject to injury are those in which the power of regeneration is most developed. With regard to the latter portion of the popular belief, Prof. Morgan has no hesitation in condemning it as unsound. The fact that in animals with "breaking joints" the regeneration may take place both above and below such joint is, he states, a sufficient demonstration of the falsity of the belief. With regard to the other part of the proposition, Prof. Morgan adduces evidence to show that the power of regeneration is characteristic of groups rather than of species; and that when exceptions do occur it is not in the case of forms specially protected from injury. "If this is borne in mind, as well as the fact that protected and unprotected parts of the same animal regenerate equally well, there is established, I think," says the lecturer, "a strong case in favour of the view that there is no necessary connection between regeneration and liability to injury."

TWO weeks ago announcement was made that the President of the Board of Trade had appointed a committee to inquire and report upon the means by which the State or local authorities could assist scientific research as applied to problems affecting the fisheries of Great Britain and Ireland. It was gratifying to record this sign of interest in the scientific aspects of our fisheries, and the appointment has not been made too early, for we learn, from a letter which Mr. W. Garstang contributes to the *Western Morning News* of August 28, that the Technical Instruction Committee of the Cornwall County Council has curtailed the grant for fishery purposes which it has been giving for the past few years, apparently as a prelude to further restrictions of the work done by the Sub-Committee for Fisheries. Perhaps the appointment of the Board of Trade committee will induce the Cornish authorities to reconsider their recent action, for they should see that the subjects which the committee have to consider are those which their own fishery expert has had under consideration since he began his investigations. Cornwall has in fact been doing what every local authority having fishery interests within its area ought to do; and to limit the scientific work it has instituted would be an unfortunate and altogether unsatisfactory conclusion of an enlightened policy. It is difficult to point to direct benefits received from such work, but the subjects of instruction and experiment carried on under the auspices of the Cornish committee ought to meet with the approval of far-seeing practical men. Our fisheries are declining at a very rapid rate, and scientific advice is needed to show how waste can be reduced and supplies increased. As Mr. Garstang remarks, there is no valid reason why biology, with suitable means and opportunities, may not do as much for our fisheries as chemistry and physics have achieved for our manufactures. "It should not be forgotten that the vast oyster fisheries of France at the present day are to a large extent the outcome of a commission given to a man of science, M. Coste, by the French Government exactly fifty years ago, when 'it is hardly an exaggeration to say there was scarcely an oyster of native growth in France.' Coste successfully introduced the Italian methods of culture into France, and his countrymen modified them to suit the local conditions, though years were spent in the needful preliminary experiments. No one to-day would assert that those years of experiment were ill-spent, although at the time their cost was doubtless greater than their immediate return."

"BRITISH RAINFALL" (for 1900) appears for the first time without the name of the late Mr. Symons, the editors of the rainfall records now being Mr. H. Sowerby Wallis and Dr. H. R. Mill. The subjects of special contributions to the new volume are the Ilkley flood of July 1900, and the development of rainfall measurement in the last forty years. In the latter article Dr. Mill gives an interesting account of the various kinds of rain-gauges which have been used, and states some of the general results obtained. Copper is generally adopted as the material for rain-gauges because it is not affected much by weather, its surface is smooth, and it is not easily broken. Ebonite is better, but it is more costly; zinc, though cheaper, deteriorates in the neighbourhood of towns or manufacturing districts. Dr. Mill suggests, however, that it might be possible to find a suitable substitute for copper among such substances as pure nickel, enamelled iron, and celluloid, with modern enamel paints. The size of the rain-gauge is immaterial, and the 5-inch gauge has been adopted as the standard because it does not collect an embarrassingly large or inconveniently small volume of water for measuring. The exposure and elevation of rain-gauges have formed the subjects of many experiments and reports, and Dr. Mill thus sums up the observations:—"The outcome of the whole matter is, that over a broad, flat surface, whether a natural feature of the ground like a plain, a plateau or flat-topped hill, or an artificial erection like a very extensive flat roof, increase of height produces no diminution in the amount of rain caught by a gauge having its mouth one foot above the surface on which it rests. But any abrupt change in the slope of the surface near the gauge, whether it be an embankment across a valley, a cliff, or a steep roof, or tower, allows the wind to set up eddies, or acquire an increased velocity, and so to reduce the amount of rain received in a horizontal gauge." These principles are clear enough, and they show the need for the adoption of a uniform height of gauge by all members of the rainfall organisation. At present it appears that not half the gauges in use are placed at exactly the standard height.

MESSRS. SWAN SONNENSCHEIN AND CO. have published a third and revised edition of "Land and Fresh-water Shells," by Mr. J. W. Williams, with a chapter on the distribution of the British land and fresh-water Mollusca, by Mr. J. W. Taylor and Mr. W. Denison Roebuck.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Mr. G. Nicholson; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. J. McCarthy; a Short-toed Eagle (*Circaëtus gallicus*) from the Atlas Mountains, presented by Captain W. R. Taylor; a Passerine Parrot (*Psittacula passerina*) from South America, presented by Mr. W. C. Stronge; two Turtle Doves (*Turtur communis*), British, presented by Miss L. Cox; a Greek Tortoise (*Testudo graeca*) from South Europe, presented by Mr. Balfour Read; a Neumann's Baboon (*Cynocephalus neumanni*) from Central Africa, a Nisnas Monkey (*Cercopithecus pyrrhonotus*) from East Africa, a Striped Hyæna (*Hyaena striata*, var.) from North Africa, three Pale Fennec Foxes (*Canis pallidus*) from the Soudan; a Brazilian Caracara (*Polyborus brasiliensis*) from South America, a Black-headed Conure (*Conurus nanday*) from Paraguay, an Egyptian Monitor (*Varianus niloticus*) from North Africa, two Brazilian Tortoises (*Testudo tabulata*) from South America, two Sculptured Terrapins (*Clemmys insculpta*) from North America, three Muhlenberg's Terrapins (*Clemmys muhlenbergi*) from North America, a Pennsylvania Mud Terrapin (*Cinosternum pennsylvanicum*) from North America, three Laughing Kingfishers (*Dacelo gigantea*) from Australia, two White-capped Tanagers (*Stephanophorus leucocephalus*) from Argentina, three Striated Tanagers *Tanagra striata*) from Buenos Ayres, four Palm Tanagers (*Tanagra palmarium*) from South America, a King Snake (*Coronella getula*) from North America, two Ocellated Sand Skinks (*Chalcides ocellatus*) from North Africa, deposited; four Lesser Snow Geese (*Chen nivalis*) from North America, two Mute Swans (*Cygnus olor*), European, purchased; a Thar (*Hemitragus jemlaicus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SPECTRUM OF NOVA PERSEI.—A communication from Prof. Pickering to the *Astronomische Nachrichten* (Bd. 156, No. 3735) gives particulars of the examination of recent photographs of the spectrum of the Nova taken at the Harvard College Observatory. The reductions show that, as has been the case in previous Novæ, the object has been gradually changing into a gaseous nebula. The resemblance to the nebula N.G.C. 3918 was so close on June 20 that no marked difference in the two spectra was noticeable. The main point of divergence is in the relative intensity of the chief nebular line at λ5007, which in N.G.C. 3918 is about eight times as bright as $H\beta$, while in the Nova these two lines are about equal in intensity.

The following lines are common to both bodies:—

3869	4688
3970, $H\epsilon$	4862, $H\beta$
4102, $H\delta$	4959
4341, $H\gamma$	5007

and with the above-mentioned exception of λ5007 are of similar intensity. Four bright lines between $H\gamma$ and $H\beta$ appear faintly in the Nova, and are not present in the nebula, while one, at λ4364, is seen in the nebula, but not in the Nova, perhaps owing to the proximity of $H\gamma$.

NEW DOUBLE STARS.—*Bulletin* No. 3, from the Lick Observatory, contains a list of 94 new double stars discovered by Mr. R. G. Aitken, with the 12-inch and 36-inch telescopes, the majority of the measures being obtained with the larger instrument. The series has been compared with Prof. Burnham's Catalogue to ensure the absence of duplicate records of previous discoveries. Classified according to distance of their components the 94 pairs show the following grouping:—

Under 0″·25	... ...	3
0·50	... ...	23
1·00	... ...	47
2·00	... ...	73
Over 5·00	... ...	1

SIX STARS WITH VARIABLE RADIAL VELOCITY.—Prof. W. W. Campbell gives particulars in *Bulletin* No. 4 of the Lick Observatory of six additional spectroscopic binaries, of which variable velocity in the line of sight has been determined from spectra obtained with the Mills spectrograph of the Lick Observatory. The details of the measures are given below:—

Star.	Extreme velocities (kilometres).	
π Cephei	−37	−5
$o_1$31 Cygni	−12	+3
ξ Piscium	+25	+35
τ Persei	+10	−4
ξ_1 Ceti	−9	+4
ϵ Hydræ	+43	+32

CAUSES OF THE VARIABILITY OF EARTHSHINE.—In the May number of the U.S. *Monthly Weather Review*, Mr. H. H. Kimball gives an interesting discussion of the probable causes of the earthshine observed on the moon's shadow side some few days previous to, and following new moon. With the idea that the amount of light reflected from the earth to the moon will vary considerably according to the condition of the earth's surface and atmosphere, a special projection chart of the earth has been prepared, showing the configuration of the continents, oceans, &c., and general atmospheric conditions (clouds, &c.), on a certain evening when the earthshine was specially prominent. If the bright portion is snow-covered, it will reflect more than a continent of forest and vegetation, and much more than a large extent of water.

A factor of considerable importance is the varying distance of the moon, and it is stated that 52 per cent. of the change in intensity of the earthshine is due to the eccentricity of the moon's orbit, and this is probably much greater than could be expected from any increase or diminution in the average cloudiness over the hemisphere of the earth reflecting light to the moon.

SOLAR RADIATION.

SOLAR radiation is a subject which has more than scientific interest. It is the source of all the energy which maintains the economy of our globe. It lights and heats the other members of the planetary system. But, after accomplishing this, only an infinitesimal proportion of the total radiation has been used. The remainder, in so far as we know, is wasted by uninterrupted dissipation into space.

The subject can be regarded and studied from either the solar or the terrestrial point of view. In terrestrial physics everything may be said to depend on the energy which, in one form or another, is supplied by the sun's rays. It is the revenue of the world, and it is of fundamental importance for us to know at what rate it falls to be received.

Roughly speaking, the surface of the earth is occupied to the extent of one-fourth by land and three-fourths by sea. Therefore at least three-fourths of the surface which the earth presents to the sun is at the sea-level. Consequently the rate at which the sun's radiant heat arrives at the sea-level is the fact which it is of the greatest economical importance to ascertain.

In considering this problem we have to answer two questions: What is the best experimental method of determining the heating power of the sun's rays at any place? and What is the best locality for making the experiment? Let us take the last first. The energy which a radiation communicates to a surface is greatest when it strikes it perpendicularly. At every moment the sun is vertical over one spot or another of the earth's surface. Therefore our first step should be to choose a locality where the sun passes through the zenith at mid-day.

Before reaching the sea-level the sun's rays have to pass through the whole thickness of the atmosphere. It is a matter of every-day observation that the atmosphere varies in transparency. The second condition is therefore to put ourselves in the position of greatest advantage as regards atmospheric conditions. Clouds and similar visible obstructions are of course excluded. The air should be motionless, the sky should be clear and of a deep blue colour in the regions remote from the sun and should contain nothing that can be called haze, or that interferes with the definition of the sun or other heavenly bodies.

From inspection alone we can only approximately ascertain what are the most favourable meteorological conditions. For this reason it is necessary to multiply observations and never to miss fine weather. In the end we cannot fail to approach nearer and nearer to the exact determination of the maximum heating power of the sun on the earth's surface at or near the sea-level, in so far as the degree of perfection of our instrumental resources permits. This limitation imposes on us the duty to continue observations, not only until the best natural conditions have been found, but also so long as the instruments or experimental methods appear to be capable of improvement. If we suppose for one moment that we have arrived at the point where no further improvement is possible, then the result of our work is the determination of the rate at which unit area of the earth's surface at or near the sea-level receives heat from the vertical sun in unit time.

There is no question here of how much is lost on the way from the sun. All that is sought, and the most that is ascertained, is how much arrives. If we multiply this by the area included in the great circle of the earth we have the amount of radiant heat which we can count on as being supplied to the whole earth in unit of time. This is the constant which is of greatest importance in physical geography.

When we have ascertained the supply of radiant heat which reaches the earth's surface, we have to inquire what becomes of it. If the heat were to accumulate the world would become uninhabitable. It cannot be doubted that long ago the earth, in this respect, arrived at a condition of equilibrium which is maintained with very slight oscillations. The fundamental principle of this state of equilibrium is that the heat which the whole earth receives from the sun in the course of a year also leaves it in the course of a year, so that, taking one year with another, the sum of the heat remains the same.

When we study the details of the annual dissipation of heat we find that the atmosphere, and especially the aqueous vapour in it, performs a very important part. Although practically transparent to the heat-rays passing from the sun to the earth, it is very opaque to those leaving the earth to pass outwards. They are powerfully absorbed and the temperature of the atmosphere is thus raised considerably above that which it would have if it were as transparent to the leaving rays as it is to the entering ones. This has no effect in permanently detaining any of the year's supply, it still disappears in the year, but not before it has produced important climatic effects.

We see in this differential behaviour of the atmosphere towards the incoming and the outgoing rays an example of Kirchoff's law, in virtue of which a body absorbs by preference the rays which it itself emits. It is exceedingly unlikely that any portion of the rays coming directly from the sun proceed from highly heated water or water vapour; we should therefore not expect the water vapour in the atmosphere to absorb them to any appreciable extent. When, however, they strike the surface of the earth, whether it be land or sea, they are abundantly absorbed. The blue water of the ocean transmits the sun's visible rays to a considerable depth. In experiments made by the writer on board the *Challenger*, a white surface, about four inches square, was clearly visible at a depth of 25 fathoms. The total length of the path of the incident and reflected ray was 50 fathoms; therefore the sun's rays which strike the sea have a thickness of at least 100 metres to work on. When they strike the land, the direct effect is superficial, but the absorptive power of a surface of soil is very much greater than that of a surface of water, and it frequently attains a very high temperature. Even in the driest countries the soil is moist, and it may be that, ultimately, the surface of every particle of the soil is a water surface. Whether this be so or not, when a land surface cools, the heat of low refrangibility which it radiates proceeds to a very large extent from water, and it is accordingly abundantly absorbed by the water vapour in the lower layers of the atmosphere. In the absence of mechanical mixture by wind, these layers can lose it only by passing it on by radiation to higher layers which contain moisture, whence it ultimately escapes into space. This accumulating function of the atmosphere provides that while every portion of the earth's surface receives heat intermittently it loses it continuously.

As the heat of the atmosphere is due to contact with, or radiation from, the surface, it must be taken from the supply that reaches the surface of the earth. Further, wind and all mechanical atmospheric effects are due to differences of density, and these are produced, not only by the thermal expansion and accompanying rise of temperature of the air, but also, and without change of temperature, by the mixture with it of a lighter gas. Such a gas is the vapour of water, and the water which supplies it is at the level of the sea. Therefore the sun's heat which arrives at the surface of the earth at or near the sea-level has to maintain not only the temperature of the surface of the globe, it has also to maintain all the mechanical manifestations of the air and the ocean. This is the ground for asserting, as above, that the only constant which is of interest in terrestrial physics is the rate at which the vertical sun heats unit area of the earth's surface at the sea-level.

The instruments used for measuring the thermal effect of the sun's rays must fulfil certain conditions. The area of the sheaf or bundle of rays collected must be accurately known; and provision must be made for the exact measurement of the thermal effect produced by them in a given time. The thermal effect produced is measured by a mass of some substance and either by the change of temperature produced in it or by the change of its state of aggregation. Actinometers, such as those of Herschel, Pouillet, Violle, Crova, are instruments of the first kind. The ice calorimeter used by Exner and Röntgen and the steam calorimeter of the writer are instruments of the second kind. The thermal mass of the substance affected is conveniently expressed in terms of the thermally equivalent weight of water, which is called its water value. In the actinometer the change of temperature is either measured by a separate thermometer or the actinometer is itself a thermometer the calorimetric constants of which have been ascertained. In instruments of the second class no thermometer is required; the thermal effect is measured by the mass of water-substance which changes its state in a given time either from ice to water or from water to steam, both being at the same temperature. In the ice calorimeter the quantity of liquefaction is measured by the change of volume, as in Bunsen's calorimeter; in the steam calorimeter the generation of steam is measured by the weight or volume of the distilled water produced. The steam calorimeter was described recently in NATURE (vol. lxiii. p. 548), and it is unnecessary to repeat it here. It acted quite satisfactorily in the writer's hands in Egypt in May 1882, and it has since been giving good results in the hands of Mr. Michie Smith at the observatory of Kodaikanal in South India, at an elevation of about 7000 feet above the sea. Theoretically, the ice calorimeter is as good as the steam calorimeter, but in applying it to the measurement of the sun's radiant heat it has a practical defect. At the moment before exposure, the ice in the calorimeter is frozen to the inner surface of the metal plate, the outer surface of which receives the sun's rays. The first effect of exposure to the sun is that the ice is detached from the plate. The intervening water introduces perturbations which are not easily allowed for.

The fundamental principle of the actinometer is analogous to Newton's second law of motion; when a body is engaged in the exchange of heat between itself and any number of other bodies, each exchange takes place independently of the others. The rate of exchange in each case depends on the difference of temperature between the two bodies and takes place on the principle that equal fractions of heat are lost or gained in equal times. A body cooling in the air is always subject to at least two quite independent sources of loss of heat, namely, radiation between itself and the surrounding objects and conduction between itself and the contiguous air. In ordinary circumstances the rate of loss of heat by radiation is subject to but little variation, but that due to conduction is subject to continual variation owing to the varying rate at which the air actually in contact with the thermometer is renewed. It is not to be expected that a body subject to at least two independent sources of loss of heat will cool in the same way as it would if exposed to only one, any more than it is to be expected that a body acted on by two forces will move in the same way as if it were impelled by only one of them. The composition of rates of cooling is like that of velocities in the same straight line; the resultant rate is the net, or algebraic, sum of all the rates. When the actinometer is exposed to the sun, its temperature rises at first rapidly, and then more slowly until, if the experiment is sufficiently prolonged, it becomes stationary. The temperature is noted at equal intervals of time. The sun is screened off, either after the temperature has become stationary or beforehand, and the temperature is observed at equal intervals during cooling. Whenever the thermometer is at a higher temperature than its enclosure, it is cooling. Therefore when it is exposed to the sun's rays, and its temperature rises ever so little above that of the enclosure, cooling begins; and what is observed in the first operation is, not the rate of heating by the sun's rays, but that rate diminished by the rate at which the thermometer is cooling. Hence, when the two series of observations have been made and tabulated, the rate of rise of temperature when that of the thermometer is, say, 2°, 4° or 6° above that of the enclosure is found. Similarly, the rate of fall of temperature when the temperature of the thermometer is 2°, 4° or 6° above that of the enclosure during cooling is found. Three pairs of rates are thus obtained. The sums of all three pairs of rates should be alike, and each gives a value of the rate at which the temperature of the actinometer would rise when exposed to the sun if there were no cooling. The rule is the same whether the temperature is allowed to rise to the stationary point or not. A distinction is often made between the *static* method, when the experiment is continued until the stationary temperature is arrived at, and the *kinetic* method, when it is interrupted before that temperature is reached. This distinction rests on no substantial difference; at the same time it is convenient to retain the designations to distinguish the manipulative processes.

Were the protecting enclosures, such as the double spherical shell packed with melting ice, used by Violle, or the thick metal shell used by Crova, perfectly efficient, then it would not be necessary to make a separate cooling experiment in connection with every heating one. The necessity for it is due to the fact that, when the sun's rays are introduced, the temperature of the air in the enclosure no longer is, and it cannot be, at the temperature of the enclosing shell; nor can it remain motionless, as it is when at a constant temperature in the shade. These perturbations, which cannot be avoided, so long as there is air in the enclosure, make it impossible to apply a rate of cooling determined beforehand. It is necessary on each occasion to determine the actual integral rate of cooling during the particular experiment.

If the actinometer could be so arranged that the rate of cooling should not be affected by the introduction or exclusion of the sun's rays, the static method could be adopted without hesitation, and the instrument would become a valuable one for continuous self-recording observations. Their value would be mainly relative. The absolute value of the sun's heat radiation, as it reaches the surface of the earth, has to be determined by other means. When it has been ascertained in the most favourable circumstances it does not vary, excepting in the annual cycle of the earth's revolution. The diurnal variation, as shown by registering actinometers, would have a great local importance. Crova, in the long series of valuable observations which he has made since 1875 at Montpelier, has, in fact, put this principle in practice.

Very important observations have been made in the neighbourhood of Chamonix by Violle and afterwards by Vallot. The Annales de l'Observatoire météorologique du Mont Blanc contain, in vol. ii., several interesting reports on the results of these observations. They were made simultaneously at Chamonix and at certain stations on Mont Blanc. The first series of observations was made in 1887 on July 28, 29 and 30, and the instruments used were two "absolute actinometers" of Violle (*Ann. Chim. Phys.* (1879) [5], t. xvii.).

The great advantage of such experiments is that they are made simultaneously at two stations situated at very different altitudes. At the higher of the two the average barometric pressure is 430 millimetres, so that 33/76 of the whole atmosphere are below the observer, and this portion contains nearly all the aqueous vapour. Above him there is a little more than one-half, and that much the simpler and purer half of the atmosphere. In it aqueous vapour is almost absent. The summit of Mont Blanc is 4807 metres and the station at Chamonix is 1087 metres above the sea. The layer of the atmosphere separating them has, therefore, a thickness of 3720 metres, and it can be visited at any point in its thickness. M. Vallot has acquired a personal acquaintance with this layer of air which can only be obtained by devoting a number of years to living in it and observing it. It is this intimate and continuous acquaintance with so large a proportion of the earth's atmosphere that entitles the observations and conclusions of M. Vallot to especially great weight.

The main results of Vallot's observations are as follows. The ratio between the heat received in the same time by the same area exposed perpendicularly to the sun's rays on Mont Blanc and at Chamonix was found to be 0·82 to 0·85, which agreed well with the proportion found by Violle in 1875. The value of the solar radiation found was, however, much lower than that found by Violle. The maximum values observed by Vallot were 1·56 gr.° C. on Mont Blanc and 1·33 gr.° C. at Chamonix, whilst Violle found 2·39 gr.° C. on Mont Blanc and 2·02 gr.° C. at the Glacier des Bossons in the valley. Violle's observed values are therefore half as great again as Vallot's. No explanation of the cause of this discrepancy is offered, but it is pointed out that the values observed by Crova at Montpelier are more in accordance with Vallot's than with Violle's. They are interesting in themselves and are worth quoting. They relate to the year 1895, the summer of which was very hot.

Intensity of solar radiation observed by M. Crova at Montpelier in 1895, in gramme-degrees per square centimetre per minute:—

Season.	Means.				Absolute maxima.	
	Monthly.			Seasonal.		
Winter	1·02	1·12	1·15	1·09	1·32	January 28.
Spring	1·20	1·13	1·13	1·15	1·38	May 12.
Summer ...	1·22	1·14	1·19	1·18	1·42	July 24.
Autumn ...	1·30	1·20	1·02	1·17	1·41	September 8.

The subject was taken up again by Vallot in 1891, and this time he used the mercury actinometer of Crova (*Ann. Chim. Phys.* 1877 [5] xi., 461).

The result of the experiments in 1891 was in the main confirmatory of those obtained in 1887. In the following table the intensities of solar radiation on September 19, 1891, are given as observed on Mont Blanc and at Chamonix:—

	Hour.	9 a.m.	10.	11.	Noon.	1 p.m.	2.	3.
Observed Radiation.	On Mont Blanc	1·34	1·30	1·36	1·38	1·34	1·33	1·31
	At Chamonix	1·11	1·16	1·19	1·15	1·16	1·09	1·01
Ratio of intensities.		0·83	0·89	0·87	0·83	0·87	0·82	0·77

The mean value of the ratio of the intensities is 0·84, as before. The values of the intensity of radiation are rather lower than those found in 1887.

In the year 1896 Prof. Ångström, of Upsala, made observations on the peak of Tenerife with a special form of actinometer depending on the heating of metal plates. He made observations at three different elevations, namely, at Guimar, 360 metres, Cañada, 2125 metres, and at the summit, 3683 metres. Reduced to a uniform thickness of one atmosphere corresponding to a pressure of 760 mm., the intensity of radiation by the vertical sun was found to be at Guimar 1·39, at Cañada 1·51, and at the summit 1·54 gramme-degrees per square centimetre per minute. These values agree more closely with the values found in 1887 by Vallot than with those of 1891. But the values found by Crova, Vallot and Ångström are all of the same order.

The writer's observations with the steam calorimeter in Egypt in May 1882 were undertaken with the object of ascertaining the maximum rate of distillation near the sea-level under the most favourable circumstances. This occurred during the forenoon of May 18, when the meteorological conditions were as favourable as they could be. The sun shone steadily in a cloudless sky, and the air was motionless. The shade temperature reached 40°·5 C. in the course of the day. Time was taken as portions of 5 cubic centimetres were distilled. The shortest time in which this quantity passed was 3m. 20s. This is at the rate of 1·5 c.c. per minute, and it occurred twice in the forenoon, namely, at 10h. 37m. and at 11h. 23m. As the collecting area of the reflector was 904 square centimetres, this corresponds to 16·6 c.c. distilled per minute per square metre. If we apply a correction for 20° zenith distance it becomes 17·04 c.c. The evaporation of 17·04 grammes of water at 100° C. requires 9116 gr.° C. of heat, so that the heat actually collected and used in making steam was at the rate of 9116 gr.° C. per square metre or 0·9116 gr.° C. per square centimetre per minute. Converting 9116 gr.° C. into work at the rate of 0·425 kilogramme-metres per gramme-degree, we obtain as the realised working value 3875 kilogramme-metres per minute or 0·87 horse-power per square metre. The reflector consists of one mirror inclined at an angle of 45° to the axis of the instrument. This mirror throws all the reflected rays normally on the surface of the axial boiler. The larger mirror outside and the smaller mirror inside of this one throw their reflected rays inclined at small angles to the normal. Taking all the reflected rays together their mean normal component is 94 per cent. of the total reflected rays. It is therefore legitimate to increase the above figures in the proportion of 94 : 100, giving 0·93 horse-power or 9700 gr.° C. per square metre per minute. The mirrors are not perfectly reflecting, nor is the blackened surface of the boiler perfectly absorbing. An allowance of 7 per cent. for these deficiencies will not be thought extravagant, and we have in round numbers the work-value of the sun's vertical rays on the surface of the earth at or near the sea-level as 1 horse-power per square metre; the equivalent of this in heat is 10,300 gr.° C. per square metre per minute, or 1·03 gr.° C. taking the square centimetre as unit of area.

Mr. Michie Smith informs the writer that the highest rate which he has observed is 1·754 c.c. distilled per minute at a height of 7000 feet above the sea. This is exactly seven-sixths of the maximum rate observed on the banks of the Nile. If we imagine that in the most favourable circumstances the radiation as determined in Egypt might be improved in this proportion we get 1·17 horse-power per square metre and 1·202 gr.° C. per square centimetre per minute as a value of the heating power of the sun at the sea-level, which is probably very near the truth.

Comparing these results with those already quoted, we see that they agree with Crova's summer values as determined at Montpelier and lie midway between Vallot's (1891) values for Mont Blanc and Chamonix. We arrive therefore at the conclusion that the rate at which the surface of the earth at the level of the sea receives heat in the most favourable circumstances from the vertical sun is 1·2 gr.° C. per square centimetre per minute, or 1·17 horse-power per square metre. In discussing questions of terrestrial physics it would not be prudent to postulate a more abundant supply.

If we ascribe to the atmosphere a coefficient of transmission no greater than two-thirds, the value of the *solar constant*, or the heating power which the sun's rays would exert on a surface of one square centimetre exposed to them for one minute at a point on the earth's orbit, is 1·8 gr.° C. As the transmission coefficient is probably greater than two-thirds, the value of the solar constant is probably less than 1·8. Vallot, by giving effect to the rate of absorption actually observed in the air separating his two stations, arrives at 1·7 gr.° C. as the most probable value. These values are in substantial agreement with the older ones, such as those of Herschel and Pouillet; but there is a feeling at present that not much weight is to be attached to these results, and much higher figures seem to be more readily accepted. In a recent work, "Strahlung und Temperatur der Sonne," p. 38, J. Scheiner sums up the discussion of this subject by giving 4 as the most probable value of the solar constant.

As we have seen, the heat which arrives at the sea-level has to support the temperature of the land and that of the sea; it has also to supply the energy for all the movements of the ocean; it has to warm and expand the air, and to furnish the latent heat represented by the aqueous vapour in the atmosphere, and it is mainly accountable for winds and storms. All this is maintained on less than 1·5 gr.° C. per square centimetre per minute. But when the above catalogue of functions has been repeated, there is nothing left to be accounted for. If the sun's rays enter at the top of the atmosphere with an intensity of 4 and come out at the bottom of it with an intensity of only 1·5, how is the loss to be accounted for? It represents nearly double the energy which reaches the sea-level and produces such far-reaching effects. If it really entered the atmosphere it must be still there, either as heat or as its equivalent. But we know that the air is not made appreciably warmer by it, and we see no mechanical manifestations which can in any way be put forward as an equivalent. We conclude therefore that there is no excess of heat of this order to be accounted for, consequently values of the solar constant of the order of 4 are exaggerated.

J. Y. BUCHANAN.

REFLEX ACTION AND INSTINCT.[1]

IN the Paris *Journal of Anatomy and Physiology* of 1869 there was reported by Robin an experiment on the body of a criminal whose head had been removed an hour previously, at the level of the fourth cervical vertebra. The skin around the nipple was scratched with the point of a scalpel. Immediately there ensued a series of rapid movements in the upper extremity which had been extended on the table. The hand was brought across the chest to the pit of the stomach, simultaneously with the semiflexion of the fore-arm and inward rotation of the arm, a movement of defence as it were.

Probably none of us have seen quite so impressive an illustration of reflex action as the above, but most of us have watched the experiment in which a frog, having been decapitated and a drop of acid having been applied to its skin, the foot of the same side is brought up to wipe away the acid, and if this foot be cut off, after some ineffectual efforts and a short period of hesitation, the same action will be performed by the foot on the opposite side. These symptoms of apparently purposive action on the part of a brainless body have always struck me as most strange.

Some four years ago I had the privilege of reading to you a paper on memory, from which I will now quote:—"When we attempt to acquire some new feat of manual dexterity, involving a series of combined muscular movements, such as a conjuring trick, we find that, when first attempted, each movement has to be thought out, and the whole is effected with difficulty. Every time that the process is repeated the action becomes more easy; each movement of the muscles involved follows its predecessor with greater readiness, and at last the trick becomes apparently one action, is performed without thought, and may be said to be automatic. The nerve structures involved have acquired a perfect memory of what is required of them; each takes up its part at the proper moment, and hands on in succession an intimation to its neighbour that it is time to transmit the expected impulse. Nerve centres have been educated. An organic memory has been established."

I went on to give instances in which, by frequent practice, actions had become so habitual as to take place on the application of the stimulus without the will of the individual, and even contrary to his wish. I gave as an illustration the story of the old soldier who was carrying a pie down the street, when some one mischievously crying "Attention!" down went the soldier's hands to his trousers seams, and down went his dinner in the mud.

Let us apply this effect of constant practice to the case in question. The frog has a smooth, soft skin, unprotected by hair or scales. His haunts are stagnant water which swarms with injurious insects and other enemies; or the banks of ponds and streams abounding in sticks and stubs. From the time when the first progressive tadpole protruded his incipient legs, the race of frogs has been brushing away irritating substances. The nerve cells of their spinal cords have established such relations that, whenever a sense of irritation is conveyed to sensory cells, motor cells in connection are brought into action, and a complicated muscular movement follows, without the necessity of the interference of the will.

We may compare the association of nerve cells in the spinal cord to a group of men highly drilled in particular evolutions. Each individual cell of the group maintains relations with others near it by some one or more of its many arms. Upon the receipt of the intimation through sensory nerves and cells that there is something burning a particular portion o the frog's skin, motor

[1] A paper read before the Derby Medical Soc ety b W. Benthall, M.B., on April 9, 1901

cells accustomed to act with these sensory cells send out messages to particular muscles. If the message is responded to, if the foot comes up and the offending particle is brushed away, the stimulus and the effort cease. If the stimulus still goes on, other cells which supply accessory muscles are called into play. If this effort to remove the offending matter is vain, and the irritation still goes on, the stimulus is passed on to other cells, which have in an emergency previously been in the habit of assisting; the stimulus thus travels to the opposite side of the spinal cord, and the other leg now comes up to the point required.

It is the effect of drill, of practice, in the forgotten past. I am aware that in making this statement I am assuming the inheritance of acquired powers—an assumption directly in opposition to the views of Weismann, who maintains that no powers acquired during the lifetime of the individual are transmitted to the progeny.

The development of the reflexes and instincts which we shall refer to will be seen to be of such importance to the maintenance of the life of the individual or to the procreation of its race; that the slow and gradual formation of nervous connections can probably be explained by the Weismann theory; but for our purposes to-night the assumption of the inheritance of acquired powers enormously increases the ease with which we can understand their development.

The idea of this paper is therefore that, as in the *individual*, constant habit causes in time such a free connection between nerve cells as to facilitate the passage from cell to cell of a particular stimulus until the action follows the stimulus automatically, so in the *race* a particular response to a particular stimulus has been repeated so often that the connection has become congenitally perfect, has become in fact what we know as a reflex. And, further, that the frequent repetition of particular actions under similar stimuli have so influenced the *intelligent* actions of the animal, that *they* also have become engrafted upon the nerve system, and recur under the influence of similar stimuli in an automatic manner; the result of these reactions of the intelligence to a particular stimulus being what we know as instincts.

The great advantage of a reflex is the certainty and usually the rapidity with which it acts. The response to the stimulus does not have to travel round through the brain. It takes a short cut. With imperfect reflexes the animal is at the mercy of its surroundings.

Nature does not pass imperfect work. The eye reflexes, for instance, have been developed by constant practice. If through their failure an animal were partially blinded, some self-constituted Factory Inspector in Nature's workshop would soon get on the blind side of that animal, and there would be no chance of its perpetuating its failings. If the cough reflex failed, some septic fly would quickly start a fatal pneumonia.

Assuming that all reflexes have been developed by practice, it follows that our own are not merely aids to the diagnosis of disease at the hands of the physician, but are now, or have been, of use in some period of our history.

A year or two ago, in the *British Medical Journal*, there was a very interesting description of the strength of the reflex grip of the newly-born infant, this being sufficient to maintain the weight of the child for some minutes while hanging from a stick. This the writer attributed to the necessities of a time before perambulators, when a child had to hang on for bare life to its mother's hair or clothes. The inward-turned feet of the newly-born child and the plantar reflex point to a time when the feet were used for climbing and for grasping.

Many of the superficial reflexes were probably developed to get rid of flies and other irritants which must constantly have troubled the naked body. The reflex action exhibited by the decapitated body, described at the commencement of this paper, was attributed by the observer to an attempt at self-defence. I think it was more probably an attempt at scratching, an act which was probably habitual in our hairy ancestors, as it is now in our poor relations at the Zoo—a movement, in fact, strictly analogous to the movement of the frog's foot incited by the irritation of the acid. To assume that there was an intention of defence in the action imports into the movement an element of consciousness for which in the absence of the brain we have no warrant; and this brings us to the question of instincts, which have been defined as reflex actions into which an element of consciousness has been imported.

I will endeavour to trace an ascending scale of instincts showing their dependence on reflex excitation. A newly-born infant has to be placed to the breast; it then seizes the nipple with its lips and sucks. There is little difference between the reflex action incited by the contact of the maternal nipple with the infant's mouth and the cough or sneeze reflex; both are complicated actions of many groups of muscles. In the one case, spasmodic; in the other, rhythmical. The young of the rabbit, born blind and helpless, nuzzles about till it finds a nipple, and then takes its hold. The lamb, calf, or fawn, guided by sight and smell, *seeks* its mother's teat. In each of these cases a stimulus is required, either of touch, sight, or smell. Without the stimulus the experiment fails.

Fawns are peculiarly precocious. From the first they show a tendency to couch and hide on the approach of danger. The following is an extraordinary instance of combination of maternal and infant instinct:—

"I have had frequent opportunities," says the "Naturalist in La Plata," "of observing the young from one to three days old of the *Cervus campestris*, the common deer of the Pampas, and the perfection of its instincts at that tender age seems very wonderful in a ruminant. When the doe with fawn is approached by a horseman, even when accompanied by dogs, she stands perfectly motionless, gazing fixedly at the enemy, the fawn motionless by her side; and suddenly, as if at a preconcerted signal, the fawn rushes away from her at its utmost speed, and going to a distance of 600 to 1000 yards, conceals itself in a hollow in the ground or among the long grass, lying down very close with neck stretched out horizontally, and will thus remain until sought by the dam. When very young it will allow itself to be taken, making no further effort to escape. After the fawn has run away, the doe still maintains her statuesque attitude, as if to await the onset; and when, and only when, the dogs are close upon her, she also rushes away, but invariably in a direction as nearly opposite to the fawn as possible. At first she runs slowly with a limping gait, and frequently pausing as if to entice her enemy on, like a partridge, duck, or plover when driven from its young; but as the dogs begin to press her more closely her speed increases, becoming greater the further she succeeds in leading them from the starting point."

In considering this case we have to remember that the deer is, as a rule, a woodland animal, and that its fawn, while feeble, crouches under cover, of which there is plenty within immediate reach; but the deer of the Pampas lives on rolling prairies where the only cover is the isolated tufts of Pampas grass. While, therefore, the instinct to crouch is sufficient for the fawns of most deer, crouching in the immediate neighbourhood of the surprise would be useless in the open ground of the Pampas; and this artful combination of tactics has doubtless been developed by practice.

In birds we get even more marked differences in connate powers and instincts, from the naked young of the sparrow, which is nearly as helpless as the human baby, to the newly-hatched chicken, which is a regular little man-about-town at once. The habits of the latter have been closely studied. Hatched out in an incubator, and deprived of all maternal instruction and example, he quickly begins to peck at all small objects, with a preference for moving ones, and from the first shows an almost perfect power of estimating distance and direction, which is very marvellous when we consider the great number of muscles which have to be co-ordinated in the act.

The late Mr. Douglas Spalding placed beyond question the view that all the supposed examples of instincts may be nothing more than cases of rapid learning, imitation, or instruction, but also proved that a young bird comes into the world with an amount and a nicety of ancestral knowledge that is highly astonishing. Thus speaking of chickens which he liberated from the egg and hooded before their eyes had been able to perform any act of vision, he says that on removing the hood, after a period varying from one to three days, "almost invariably they seemed a little stunned by the light, remained motionless for several minutes, and continued for some time less active than before they were unhooded. Their behaviour was, however, in every case conclusive against the theory that the perceptions of distance and direction by the eye are the result of experience or of associations formed in the history of each individual life. Often, at the end of two minutes, they followed with their eyes the movements of crawling insects, turning their heads with all the precision of an old fowl. In from two to fifteen minutes they pecked at some speck or insect, showing not merely an instinctive perception of distance, but an original ability to judge and to measure distance with something like infallible accuracy. A chicken was unhooded when nearly three days old. For six minutes it sat chirping and looking about it; at the end of that time it followed with its head and eyes the movements of a fly twelve inches distant, at twelve minutes it made a peck at its own toes, and the next instant it made a vigorous dart at the fly, which had come within reach of its neck, and seized and swallowed it at the first stroke; for seven minutes more it sat calling and looking about it. For about thirty minutes more it sat on the spot where its eyes had been unveiled without attempting to walk a step. It was then placed on rough ground within sight and call of a hen with a brood of about its own age. After standing chirping for about a minute, it started off towards the hen, displaying as keen a perception of the qualities of the outer world as it was ever likely to possess in after life. It never required to knock its head against a stone to discover that there was no road there. It leaped over the smaller obstacles that lay in its path and ran round the larger, reaching the mother in as straight a line as the nature of the ground would permit. This, let it be remembered, was the first time it had ever walked by sight."

In this experiment each movement of the chicken appears to have been started by an external stimulus. It pecked at the flies which it saw. It jumped or evaded the objects which it saw in its path. It remained stationary until its hereditary tendencies were stimulated by the sound and sight of the old hen in its neighbourhood.

Mr. Spalding again says:—"The art of scraping in search of food, which, if anything, might be acquired by imitation, is nevertheless another indubitable instinct. Without any opportunities of imitation, when kept quite isolated from their kind, chickens began to scrape when from two to six days old. Generally the condition of the ground was suggestive, but I have several times seen the first attempt, which consisted of a sort of nervous dance, made on a smooth table." Mr. Spalding, however, does not seem to have seen them scrape unless the ground was suggestive, and Dr. Allen Thompson hatched out some chickens on a carpet where he kept them for several days. They showed no inclination to scrape because the stimulus applied to their feet was of too novel a character to call into action their hereditary instinct; but when Dr. Thompson sprinkled a little gravel on the carpet and so supplied the appropriate or customary stimulus, the chickens immediately began their scraping movements. Here, again, we see the hereditary instinct requiring a local stimulus to bring it about.

Mr. Spalding again says:—"A young turkey, which I had adopted when chirping within the uncracked shell, was on the morning of the tenth day of its life eating a comfortable breakfast from my hand, when the young hawk in a cupboard ust behind us gave a shrill chip, chip, chip. Like an arrow the poor turkey shot to the other side of the room, stood there motionless and dumb with fear, until the hawk gave a second cry, when it darted out at the open door right to the extreme end of the passage, and there, silent and crouched in a corner, remained for ten minutes. Several times during the course of that day it again heard these alarming sounds, and in every instance with similar manifestations of fear." Generations of young turkeys must in their native home have had cause to dread the cry of birds of prey; and the hereditary lesson had been well learned.

A water-bird was reared from the egg by another observer. It would swim freely, but he could not get it to dive by any means which he tried. One day while watching it in the water, a dog suddenly appeared on the bank. The necessary stimulus was applied; the hereditary reflex was set in action, and in the twinkling of an eye the bird had dived.

Handed down from generation to generation as these instincts have been, and impressed upon their owners by the imperative law that failure to inherit an instinct or a reflex meant death to the degenerate, these reactions persist long after they have failed to be of use.

As Dr. Louis Robinson has pointed out, the horse roamed, in a wild state, over plains of more or less long grass and low bushes. When a horse is alarmed, he throws up his head to get as wide a view as possible. The cow on the other hand keeps her head low, as if to peer under the boughs which covered the marshy grass of her jungle home. The horse's chief danger lay when, as he approached a stream to drink, he was liable to be sprung upon by a lurking lion; and to this day the two things that a horse dreads most are the rustling in bushes or reeds by the road-side and the wheelbarrow or tree-stump which his imagination depicts as a crouching enemy.

The dog once formed his lair in rough stuff, and now, when approaching sleep gives the accustomed stimulus, our pet dogs turn round three times upon the hearthrug to smooth down imaginary grass stubs. As an instance of an instinct which by its persistence under altered circumstances has become actually prejudicial, I may give the case of some shore-birds which had for many years nested upon flats covered with pebbles. As long as the pebbles remained, the eggs, which closely resembled them in markings, were rendered inconspicuous, but as the sea receded and grass grew, the pebbles became few and far between. The birds still, however, kept to their haunt, and actually collected pebbles around their eggs, thereby rendering their nests the more conspicuous.

In domestic fowls the habit of cackling as soon as they have laid an egg would certainly be detrimental to a wild race, and Hudson makes some interesting remarks on the modified habit in a semiferal race. The Creolla fowls, descended through three hundred years from the fowls introduced by the early settlers in La Plata, are much persecuted by foxes, skunks, &c., ever on the look-out for their eggs or themselves. These fowls in summer always lived in small parties, each party composed of one cock and as many hens as he could collect—usually three or four. Each family occupied its own feeding-ground, where it would pass a greater portion of each day. The hen would nest at a considerable distance from the feeding-ground, sometimes as far as four or five hundred yards away.

After laying an egg she would quit the nest, not walking from it as other fowls do, but flying, the flight extending to a distance of from fifteen to about fifty yards; after which, still keeping silence, she would walk or run, until, arrived at the feeding-ground, she would begin to cackle. At once the cock, if within hearing, would utter a responsive cackle, whereupon she would run to him and cackle no more. Frequently the cackling call-note would not be uttered more than two or three times, sometimes only once, and in a much lower tone than in fowls of other breeds. If we may assume that these fowls in their long semi-independent existence in La Plata have reverted to the original instincts of the wild *Gallus bankiva*, we can see how advantageous the cackling instinct must be in enabling the hen in dense tropical jungles to rejoin the flock after laying an egg, while if there are egg-eating animals in the jungle intelligent enough to discover the meaning of such a short subdued cackle, they would still be unable to find the nest by going back on the bird's scent, since she flies from the nest in the first place! It is obvious that while this form of cackling is useful, excessive cackling would in a state of nature lead to its own suppression.

We may suppose that as the wild fowl became more and more closely domesticated the eggs of the greater cacklers were more rapidly found and preserved by their mistresses, and this tended to increase the tendency to cackle; while in the half-wild fowls of settlers who had plenty to do besides looking after their poultry, there was a gradual reversion to the wild type by the elimination of the eggs of loud cacklers when not rapidly retrieved.

Birds which nest within a short distance of the ground display, as a rule, great skill in concealing their nests, and are very conservative in type. How is it that one chaffinch's nest is so like another's?

Gregarious birds like rooks have opportunities for learning by imitation, and may thus have lost some of their spontaneous skill. I have read somewhere that, when rooks were introduced into the Antipodes, young birds having been selected for transportation, they were found, when the breeding season came round, to be at fault, and finally imitated the nest of some native bird; but chaffinches build apart from one another; how, then, do they get their nests so nearly alike? A great observer has suggested that this is due to recollection on the part of the nesting pair of the home in which they were reared. This explanation does not commend itself to my mind, and is refuted, if not by the instance of the rooks just quoted, by the fact that tame canaries hatched in a nest of felt will, when they themselves breed, use moss for the foundation of their nest, and hair as a lining, just as a wild bird would do, although, as they build in a box, the hair alone would be sufficient.

If you want examples of what pure instinct can do, go to the insect world. There you get them in infinite variety. Hatched from the egg long after the death of the mother, the majority of insects have to depend entirely on the duly ordered reaction of their nervous organisms to stimuli similar to those which have for ages incited their forerunners.

The bot of horses has been hatched from the egg inside the stomach of its host. After some nine months' residence in the intestines, it is passed with the fæces and subsequently becomes the bot-fly. Until it becomes a perfect insect it has never seen the outside of a horse, and yet, as soon as it sees one, it knows exactly where to deposit its eggs in a position from which they can be licked off and swallowed in their turn. The sight and perhaps the smell of the horse is sufficient to inspire the hereditary desire to deposit eggs in a particular spot. If the stimulus and its reaction were insufficient, that particular bot-fly would cease to propagate.

The garden spider, again, hatched from an egg laid the previous autumn, brings an enormous amount of hereditary skill into the vicissitudes of its life. It selects its site, builds its web, adapts it according to the most approved plans to fortuitous circumstances, and distinguishes between harmless flies and dangerous wasps with an innate cunning which is an exact replica of the actions of the last year's brood. The nest of the trapdoor spider, too, is quite as wonderful a production as the nest of any bird.

Caterpillars, when they have reached their full growth, display great skill in selecting appropriate hiding places in which to pass into the chrysalis form, and those which weave cocoons do so in recognised stages. Huber has described one which makes, by a succession of processes, a very complicated hammock for its metamorphosis; and he found that if he took a caterpillar which had completed its hammock up to say the sixth stage of construction, and put it into a hammock completed only to the third stage, the caterpillar did not seem puzzled, but completed the fourth, fifth, and sixth stages of construction. If, however, a caterpillar were taken out of a hammock made up, for instance, to the third stage, and put into one finished up to the ninth stage, so that much of its work was done for it, far from feeling the benefit of this, it was much embarrassed, and forced even to go over the already finished work, starting from the third stage which it had left off at, before it could complete its hammock. In this experiment it would appear that each instinctive action calls other actions in definite order, and unless the proper sequence is maintained the intelligence of the insect is unequal to bridging the gap.

Now let us apply the facts and inferences aforesaid to the nesting of the chaffinch. We have seen how habits acquired during the life-time of the individual impress themselves upon the nervous connections, until, when the accustomed stimulus is applied, they become quite independent of the will. We have seen how certain reflex phenomena which are necessary for the life of the individual have, through congenital connections, become so automatic, that they take place whether the brain is present or not. We have seen how habits of wild animals have, through similar nervous bonds, been handed down to tame descendants long after the said habits were useless and even detrimental. We have noted that ancestral habits may lie in abeyance until some perhaps unexpected stimulus arouses them—for instance, the scraping of chickens when placed upon gravel, or the diving of a water-bird upon sudden fright. We have ascertained that many of these instincts are certainly not due to instruction by older animals, but are purely spontaneous; that in insects these spontaneous actions are often most complicated, and are sometimes *not only* carried out in definite order, as in the weaving of their cocoons, but *cannot* be carried out except in that definite order.

The inference I draw is that the nest-building of the chaffinch is due to a succession of reflexes. You remember that when Alice was wandering about in Wonderland, she was continually coming upon medicine-bottles, marked "Drink me," or upon pieces of cake, marked "Eat me." You remember that when Alice obeyed these directions strange things happened. Alice was able to decipher her labels by the result of long and painful study in her nursery. Had they been written in the Cuneiform character, though perhaps perfectly intelligible to another, they would have conveyed nothing to her. The nervous system of the chaffinch has been educated by generations of hereditary experiences, and when the newly-wedded chaffinch pair start upon their housekeeping, they see in their mind's eye, upon some suitable site, a label marked "Build here"; they go through the stages of their architecture much as the caterpillar spins the different stages of its cocoon, each stage suggesting its successor; and each twig, hair, or feather which they use, bears upon it a label, "Use me next."

THE EDUCATION OF ENGINEERS.

SEVERAL papers on the training of engineers have recently come under our notice, and it seems worth while to bring together some of the expressions of views upon this important subject. It is difficult, if not impossible, to lay down any hard and fast line as to the course to be adopted by a youth who wishes to become a qualified engineer, for the way to follow must depend largely upon the position, age, prepotency and previous training of the aspirant. Assuming, however, that the principles of science have been studied at school, with practice in the physical laboratory, the question is, what is the next step to be taken? The answers to this are many and various, as will be gathered from the following notes from recent papers on the subject.

A paper on the training of electrical engineers, read by Dr. J. T. Nicolson before the Manchester section of the Institution of Electrical Engineers and published in the *Journal* of the Institution (May 1901, No. 150), with the discussion upon it, contains some noteworthy statements. The province of the laboratory in the scheme of electrical engineering is, Dr. Nicolson remarks, first to extend scientific knowledge by providing more experimental data; secondly, to show the student the scope, value and limitations of the theories he has studied in the class-room; and thirdly, to provide object-lessons on the general trend of electrical engineering design by means of machines and instruments of the newest types procurable.

Theory must not, however, be neglected. "Resting on a strong foundation of mathematics, physics and chemistry, the knowledge of the engineer must always include such pure sciences as those of kinematics, dynamics, hydrodynamics, thermodynamics and electrodynamics. A sound elementary acquaintance with all of these is necessary, and a specialised knowledge of that one more particularly useful to the engineer in his own branch must be obtained. It is, for instance, quite hopeless to try to explain to a man who has no knowledge of dynamics, upon what principles one proceeds in endeavouring to balance a locomotive. No amount of laboratory experiment will enable him to dispense with a knowledge of the mechanical principles involved. Again, the fundamental principles of thermodynamics may not be of much use in helping a man to fix the size of the cylinders of a steam engine; but they will, at all events, keep him from wasting his time in trying to design a perpetual-motion machine, and they will show him how far he can hope to go in the direction of the improvement of his heat motors, or other energy transformers." As Prof. Perry has said:—"An electrical engineer must have such a good mental grasp of the general scientific principles underlying his work that he is able to improve existing things and ways of using these things."

This latter qualification, a knowledge of theory, he must acquire by private study and from his college lectures; the former will be best inculcated by experimental work in the laboratory. In the electrical profession, considerable difference of opinion exists concerning the stage at which a youth should enter the works, if he is free to choose. Dr. Nicolson holds strongly the opinion that, after leaving school, the boy who intends to become an electrical engineer should first spend at least two years in the workshops of a *mechanical engineer.* Here he will learn the elements of smithing, moulding, pattern-making, fitting, machine-work and erecting. In this time he cannot help picking up the names and appearance of the common implements and processes fundamental to all kinds of engineering practice. Having put in two years in a mechanical engineering workshop, Dr. Nicolson thinks the student ought to enter an engineering college at about the age of eighteen, and he ought to study there for not less than three years.

"This last portion of his laboratory time should be devoted by our embryo electrical engineer to what is, in America, called 'thesis' work. This is of the nature of an experimental research, carried out either by the student himself or by a small group of students of which he is one. Very much valuable information has been obtained in American colleges in this way, regarding the various types of new apparatus continually coming out; and it is found that the students learn, in the course of such work, to assume responsibility by being in a large measure left to their resources. Such investigation usually requires either special apparatus or the loan of new types of machinery; but good work may also be got by making progressive tests of an operating plant either in the college or elsewhere."

In the discussion upon Dr. Nicolson's paper, the view that an interval between school and college should be passed in an engineering works was not generally accepted. In the opinion of most speakers, it is better for a youth to go straight from school to a technical college for three years, and to obtain workshop experience after the college training, than to enter works at once. Dr. E. Hopkinson pointed out that for a boy to leave school at about the age of sixteen, and to enter a workshop with the idea of returning to school or college after an interval of two or three years involves a break in the scholastic course, and in habits of learning, which often has disastrous results. The best men are usually those who have had a continuous school and college career up to twenty-two or twenty-three years of age.

Another plan proposed is a combination of the half factory and half technical school, and this system is now under the consideration of the Manchester Association of Engineers. Mr. M. P. Higgins advocates the establishment of schools of this kind in an article in the August number of *Feilden's Magazine*. Such a school should, he says, possess the following features:—(1) a first-class commercially successful and productive machine-shop, which is a department coordinate in importance, influence and educational value with the academic department; (2) the pupils to be given instruction and practice in this shop during half the working hours in five days of each week, for a period of four years; (3) instruction in the public schools to be given during a portion of the other half of the time, equivalent to a high-school course, restricted, abridged and improved to meet the needs of these pupils; (4) special care and method of selection of pupils who have finished the grammar-school course and who have special aptitude for mechanical work; (5) management under a corporation whose trustees shall be practical business men.

If technical colleges were equipped with ordinary commercial apparatus and machines and kept in complete touch with engineering advances, much of the difficulty as to training would be removed, for students at such colleges would be able to combine the realities of the workshop with the theoretical instruction. But, as Dr. Nicolson pointed out in his paper, the data available in an engineering school are seldom of the latest, unless the teacher spends his summer in obtaining them. The instructor in electrical engineering has the special difficulty of the newness and constant development of his subject to contend with; but if he follows the practice of every year visiting the plants of the manufacturing companies and typical light and power stations, information is obtained which cannot be found in engineering literature and which has the highest value for educational purposes. The cultivation of close relations between the college and the practising profession should, indeed, be part of the duty of instructors and ought to be eagerly reciprocated by the working engineers as one of the surest ways of meeting foreign competition.

The closer sympathy between science and industry is, indeed, probably the most important factor to be considered. Engineers should see that technical colleges are brought into contact with current work, and arrangements might be made whereby young men from works could be sent from works to the laboratories of scientific institutions to carry on researches for the benefit of the firms employing them. This system is already partly in vogue in Germany and America, and has produced very gratifying results.

This summary of opinion may appropriately be concluded with some extracts from an article on the engineer of the twentieth century, by Prof. V. C. Alderson, Dean of the Armour Institute of Technology, Chicago.

"In the realm of mathematics the training of the engineer will be most rigid and exact. He will cut loose from the idealistic, academic mathematics, as the student of higher literature will cut loose from mere grammars. His mathematics must run down through his fingers, as it were. Mere juggling with symbols will be useless to him. He must regard his mathematics as one of his tools, as a means to an end, or as a language in which to express his thoughts. The future engineer may be successful if his training has included a greater or less amount of shop practice with perhaps indifferent laboratory instruction and a meagre equipment, but no engineer can be broadly successful and thoroughly competent without a deep and exhaustive theoretical treatment of engineering subjects. This does away with the common opinion that literature and books are not essential to the engineer's success, for the next quarter of a century will see the engineering profession rise to the dignity of the older professions.

"The conditions which will beset the engineer of the twentieth century will be exacting beyond anything we now know. The importance of a strong foundation in scientific principles cannot be over-estimated, for scientific principles are only the laws of nature. These principles cannot be learned readily after a man has begun his life work. His whole energy will then be devoted to applying these principles correctly, not in acquiring them laboriously. It will be a prime necessity for the technical college of the future to lay these foundations broad and deep. It will be regarded as a weakness for a college to teach its students only the knacks of the profession, only just enough to be an ordinary draughtsman, a tolerable surveyor, or first-class linesman.

"The technical graduate of the twentieth century will be marked by certain characteristics which are too rarely found in men trained in the colleges of literature and arts. Among these are directness of purpose, intellectual accuracy and clear thinking. The student of science and technology is trained in the realm of realities, where to commit error, to act without purpose, or to think vaguely are seen at once to be fruitful of harm. Economic and industrial needs will bring education from the cloistered lecture-room into the open air of the laboratory. Technical education will have a practical, helpful bearing upon the problems of life. No longer will the seclusion of the scholar be a mark of honour. Education will be found at the bench, by the forge, in the shop, the laboratory and the drafting-room, as well as in the library. The lesson to be taught will be how to apply scientific ideas to the solution of problems actually arising in the struggle to bring the forces of nature under the sway of man.

"As technical education develops, questions of far-reaching importance must be settled. Probably the most important will be the decision as to what kind of man shall guide the technical college. In law, medical and theological schools, the lawyer, the doctor and the minister, respectively, hold first place and have much to say both in the actual training and in the management of the schools. Prominent members of the profession direct the destinies of the schools. To a much less extent do practising engineers influence the technical schools.

"The engineering college represents that form of scientific education most suitable to the exacting demands of advancing civilisation. The particular form of education which it gives through shop and laboratory practice, through practical tests, through acquaintance with the needs of industry, must not and will not be retarded by the classic heirlooms of the literary college. The engineering college must fill its own niche and work out its own salvation. Technical education is an educational and not an engineering problem.

"The technical college in which the future engineer is to be trained has several important characteristics to maintain. First, to educate scientifically and technically those who shall lead the march of the coming civilisation in industrial lines; second, to educate the public to a true sense of the value of applying scientific principles to industrial processes; third, as the university has for one of its functions the extension of human knowledge in any and all lines, so the technical colleges will recognise that the investigation of questions relating to applied science is within its own sphere of usefulness. Probably no investigation to-day would be more fruitful of good results to the engineering profession and to the public at large than the systematic study and thorough test of materials of construction. Such an investigation done on a large scale, on specimens of full building size, in a scientific manner, would save millions of dollars and put the science of construction on a scientific and economic basis. While the university asks no questions about the usefulness of the information gathered within its walls, the technical college must make its investigations in fields that are distinctly useful."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LORD AVEBURY referred to the neglect of scientific education in secondary schools, in an address delivered at Nottingham on Tuesday, before the Association of Chambers of Commerce of the United Kingdom. He pointed out that the public schools are legally bound, by the regulations made by Lord Salisbury's Royal Commission, to give in all examinations one-eighth of the marks for mathematics, one-eighth for modern languages, and one-eighth for science. How science fares may be judged by the fact that one public school with 900 boys has four science masters, and another with 500 boys only has three. In fact, the complaint made long ago by Ascham and Milton, and reiterated by Royal Commission after Royal Commission, still holds good to a great extent.

THE following list of successful candidates for Royal Exhibitions, National Scholarships, and Free Studentships (Science), 1901, has been issued by the Board of Education, South Kensington:—*Royal Exhibitions.*—Walter Smith, Henry F. C. Walsworth, Alec J. Simpson, James C. Smail, John Good, Sydney F. Paul, George E. Piper. *National Scholarships for Mechanics.*—George W. Phillips, Alfred W. Steed, David P. Grubb, Thomas G. John, Henry J. Jones. *Free Studentships for Mechanics.*—Herbert G. Tisdall, Thomas Chester. *National Scholarships for Physics.*—George W. Andrew, Leonard Southerns, John B. Homer, Sydney H. Higgins, Roger E. Grime. *Free Studentship for Physics.*—Otmar U. Seeman. *National Scholarships for Chemistry.*—Herbert B. P. Humphries, Alfred Shepherd, Alfred Berry, Donald Levy, Sydney H. Smith. *Free Studentships for Chemistry.*—Joseph A. Stokes, John F. Stansfield. *National Scholarships for Biology.*—Arthur R. Mynott, Alfred Eastwood, Richard C. Bristow, Malcolm Wilson. *Free Studentship for Biology.*—Florence E. Pratt. *National Scholarships for Geology.*—John E. Haworth, Claude G. Sara, Tobias Clegg.

THE candidates successful in the recent competition for the Whitworth Scholarships and Exhibitions are announced by the Board of Education, South Kensington, to be as follows:—Scholarships, 125*l.* a year each (tenable for three years)—Charles E. Handy, John E. Jagger, Albert Wilson, James C. Macfarlane. Exhibitions, 50*l.* (tenable for one year):—Thomas P. Shilston, Arthur Baker, George W. Phillips, George H. Andrews, John S. Nicholson, Henry F. C. Walsworth, Thomas G. John, Harry J. Wickham, John Good, James C. Smail, Gilmour E. Brown, George E. Piper, Alexander Gray, Arthur H. Sturdee, Harry Topham, Reginald Lavender, William H. Snow, Richard F. Barber, Harold Scragg, Harold E. Morrow, Thornton Knowles, John Ingham, Percy M. Bennett, Ernest G. Beck, Alfred G. Fox, Harold Fowler, Frank Lord, Thomas Chester, William E. Gardner, Roland W. Parry.

FROM particulars given in the thirteenth annual report just published by the National Association for the Promotion of Technical and Secondary Education, it appears that considerably over a quarter of a million of money (or 286,980*l.*) has become involved during the past year for the structural development of technical schools in England. If this sum be added to the trustworthy estimate of 2,643,172*l.* given in last year's report, it shows that the total amount incurred in England (excluding London) for 295 schools under municipal and public bodies is now at least 2,930,152*l.*; if all outlays upon other schools could be definitely assessed, this sum would doubtless reach more than 3,000,000*l.* (excluding London). The largest of the new building schemes is that of Bolton, the estimated capital outlay being 80,000*l.* The school will be established to a considerable degree upon Continental models, and will form one of the most important centres of technological training in the country. In Liverpool, 14,500*l.* is to be utilised for the equipment of a central technical school costing over 100,000*l.*; an important movement towards centralisation is consequently now taking place in that city.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 26.—M. Bouquet de la Grye in the chair.—Remarks by M. Janssen upon some observations of the Perseids from the Observatory at the summit of Mont Blanc.—On the application of the principle of energy to electrodynamic and electromagnetic phenomena, by M. E. Sarrau.—Critical remarks concerning the determination of sex in the Lepidoptera, by M. Alfred Giard. In discussing the results of the experiments of M. C. Flammarion upon the influence of colours in the production of the sexes in *Sericaria mori*, the author points out certain morphological data which modify the interpretation of the experiments considerably. In the opinion of the author, the great error of physiologists in studying questions of this order, as in many others, is in completely neglecting the morphological data, and in considering the animal or vegetable egg as a point of absolute departure, instead of a complex of energies accumulated by the varied conditions of existence or found in the ancestral organism.—On the mode of action of the brakes of automobiles, by M. A. Petot. From the formulæ usually employed to express the relation between the inertia and the co-efficient of adherence it can be deduced that it ought to be impossible to stop an electric tramway as rapidly as another vehicle, under similar conditions of speed and adherence. It is shown in the present note that this is an error, due to an inexact interpretation of the function of adherence during the application of the brake.—On the constitution of white light, by M. O. M. Corbino. According to M. Gouy, the different rays constituting the spectrum of white light are sinusoidal and perfectly regular components of one single complex vibration of any form whatever, and hence it follows that these components, their amplitude and phase remaining invariable, can interfere. According to M. Carvallo, the radiations separated by a grating are independent and consequently cannot interfere with each other. According to the author, the production of a system of mobile fringes in a channeled spectrum affords a crucial test of these two views. From these it is concluded that two radiations taken from different points of a continuous spectrum produced by white light are completely independent, and that in consequence it is impossible to consider them as two sinusoidal components of a single complex vibration.—The sexual elements and copulation in Stylorhynchus, by M. Louis Léger.—On a bacterial disease of the potato, by M. G. Delacroix. The disease in question, which is very prevalent in the centre and west of France, is due to a bacterium which appears to be identical with the *Bacillus Solanacearum* of E. F. Smith. It possesses the same characteristics on cultivation, and the symptoms of the disease observed in the United States on potatoes and tomatoes are similar to those observed in France. The only suggestion that can be put forward as a remedy is a triennial variation in the crops in order to clean the soil, which appears to be the vehicle of the disease, from the pathogenic organisms which it contains.—The invasion of streams of water in the department of Hérault by *Jussiaea grandiflora*, and on the growth of this species in France, by M. P. Carles. The growth of this plant in some districts is so great that it forms true aquatic prairies. It has been stated that this plant could not fructify in France, but this is now shown to be inaccurate, since in the month of September on the River Orb the fruit was formed in the shape of capsules about 29 mm. in length, each capsule having five divisions containing about fifteen seeds. It is by these seeds that it multiplies so abundantly.

CONTENTS.

THURSDAY, SEPTEMBER 12, 1901.

CARNAC AND STONEHENGE.

(1) *The French Stonehenge: an Account of the Principal Megalithic Remains in the Morbihan Archipelago.* By T. Cato Worsfold, F.R.Hist.S., F.R.S.L. Pp. 44. (London: Bemrose and Sons, Ltd. No date.) Price 5*s*.

(2) *A Sentimental and Practical Guide to Amesbury and Stonehenge.* By Lady Antrobus. (Salisbury: Brown and Co., 1901.)

MR. WORSFOLD'S book, though the reason for its title, "Stonehenge," is not very apparent, gives a popular and interesting account of the wonderful megalithic works at Carnac, in Brittany. Those who desire to enter more deeply into the subject should consult "Les Alignments de Kermario," par James Miln Rennes (1881), a work which our author appears to have well studied, and "L'Astronomie Préhistorique," par F. Gaillard, dans la *Révue Mensuelle Internationale des Sciences Populaires* (15 Rue Lebrun, Paris).

Let us, however, accompany Mr. Worsfold in the slighter introduction which he gives. A lucid glance at the inhabitants of the district, which, with the peninsula of Quiberon, is part of the Department of Morbihan, is given in "Cæsar's Commentaries" (De Bello Gallico, iii. 3), describing his naval engagement with the Veneti, who seem to have been assisted by allies from Britain (Cæs., iv. 20). From this account it appears that the Veneti had evidently attained to no inconsiderable height of civilisation, as particularly shown in the construction and fittings of their ships. Our author adds the tradition that after their defeat the Veneti sailed away to the Mediterranean and founded the city of Venice. A description of Carnac follows.

The three great heads into which the megalithic remains may be divided are:—

(*a*) Menhirs, or single stones, in most cases upright, but occasionally overthrown. These, when they appear in circles, are called cromlechs.

(*b*) Dolmens, from Dol Men, a table stone consisting of a flat stone resting on two or more upright stones having subdivisions, "Dolmen a galérie" having an entrance way of sufficient height, and "Galgal," similar but smaller, "Dolmen à l'allée couverte" and "Kist-vaen," which should, indeed, be under another head, meaning stone coffins hewn out of one block.

(*c*) Alignments, which are lines of menhirs. These form the chief objects near Carnac. The finest dolmens are near Locmariaquer, a village about eight miles distant.

A large and lofty tumulus near Carnac, named Mont St. Michel, from a church so dedicated, which has been built upon it, has yielded on excavation many prehistoric relics; and near its base was found the remains of a Roman villa with Celtic or pre-Celtic relics arranged on shelves, showing that its Roman owner had been somewhat of an antiquarian. The name of the place is supposed to be derived from this tumulus or *cairn*. That this tumulus may have been connected originally with sun worship may be argued from the fact that the annual custom prevails of lighting a large bonfire on its summit at the time of the summer solstice, which is the signal for others to be kindled on similar prominent eminences for a distance of twenty or thirty miles round. These fires are called in the local patois "Tan Heol," and also by a later use, Tan St. Jean.

This practice prevailed also in Scotland under the name of Bel Tan, or Baal's Fire; the synonym for summer used by Sir Walter Scott in the "Lady of the Lake":—

> Ours is no sapling chance-sown by the fountain
> Blooming at Beltane in winter to fade.

The alignments of Carnac consist, firstly, of those known as "Le Menec," signifying *the place of stones*, or, by another interpretation, *the place of remembrance.* The next series are those of Kermario, or *the place of the dead.* The third series, Kerlescant, or *the place of burning.*

The alignments of Menec consist of eleven lines of menhirs, terminating towards the west in a cromlech, and notwithstanding that great numbers have been converted to other uses, still contain 1169 menhirs; some, however, do not exceed 18 inches in height, but others reach as much as 18 feet.

The alignments of Kermario in ten lines contain 989 menhirs. That of Kerlescant, which beginning with eleven rows is afterwards increased to thirteen, contains altogether 579 stones and thirty-nine in its cromlech, with some additional stones in a northerly direction. Each of these three alignments has its own orientation, and the large menhirs at the ends are supposed by some persons to mark the rising and setting of the sun, in some cases at the equinoxes and others at the solstices. In connection with this it is interesting to state that at Kerlescant the winter solstice is celebrated by a holiday, whilst Menec greets the summer solstice, and Kermario the equinoxes, with festivals. It appears that the adoration paid these stones remained strongly rooted for many centuries and yielded very slowly to Christianity. This is shown by the constant denunciations made against it in different countries. In the church history of Brittany in particular, the *Cultus Lapidum* was denounced in 658 A.D., and a decree was passed at Nantes that trees so worshipped should be torn up and burnt and stones cast down and hidden from those who sought to do them reverence. Indeed, the author quotes M. de Fréminville, who writes:—

> "On sait qu'au dix-septième siècle même l'idolâtrie était encore exercée dans l'isle d'Ouessant [*i.e.* Ushant] et dans plusieurs paroisses de l'évêché de Vannes." [Vannes is about twenty miles distant from Carnac.]

In connection with this it is stated that some years since a large number of these menhirs were lying prone on the ground exactly due north and south, and were subsequently restored to their original position by the French Government. These stones may have been overturned in compliance with the decree of 658 A.D. above referred to. Several of the loftier menhirs have been surmounted by crosses of stone or iron, so as to convert, at any rate, the appearance of veneration into an orthodox channel.

After a digression upon Stonehenge, presumably for the purpose of justifying the title of the book, but in which no very apparent analogy is pointed out, he cites Avebury, where it may be admitted that the character of the stones, but not the arrangement, is more suited for comparison. He returns to Morbihan and describes the monuments near Locmariaquer, and especially the "Dolmen des Marchands," about two miles from the village, where a granite block about 36 feet in length is poised in a horizontal position upon three others 16 feet high, the under surface being carved in a curious manner with undulating grooves and with hieroglyphics of axes interspersed. Then follows the account of a huge stone now lying on the ground which has been broken into five pieces, but presumably was once erect and stood 78 eet in height and 13 feet across at the base, weighing about 340 tons.[1]

Near Locmariaquer in the estuary named Riviere d'Auray, there is an island named Gavr' Inis, or Goat Island, which contains a good specimen of the kind of dolmen which has been named "Galgal."

"At the entrance our attention is at once arrested by the profusion of tracery which covers the walls. From the entrance to the wall facing us the distance is between 50 and 60 feet. The square chamber to which the gallery leads is composed of two huge slabs, the sides of the room and gallery being composed of upright stones, about a dozen on each side. The mystic lines and hieroglyphics similar to those above mentioned appear to have a decorative character."

An interesting feature of Gavr' Inis is its remarkable resemblance to the New Grange tumulus at Meath. In construction there is again a strong resemblance to Mæs-Howe, in the island of Orkney. There is also some resemblance in smaller details.

In excavations near Carnac and Locmariaquer, many curious prehistoric implements and ornaments have been discovered, which are preserved in the Miln museum at Carnac and in a museum at Vannes.

The main purpose of Lady Antrobus' sentimental and practical guide is to give a popular account of the interesting objects in the neighbourhood of Stonehenge, and especially of Stonehenge itself, and in this it succeeds admirably. The sentimental part is very well worth reading, but it is more in accordance with the intention of this article to proceed to the practical part, which is a very useful *résumé* of the chief authorities on the subject, and it is illustrated by some well-chosen photographs. The account begins with a translation from Diodorus Siculus, who lived about B.C. 8.

Hecatæus, the Milesian (who lived about 500 years B.C.), gives us the following story :—

"Over against Gaul, in the great ocean stream, is an island not less in extent than Sicily, stretching towards the North. The inhabitants are called Hyperboreans. It is said that the soil is very rich and fruitful, and the climate so favourable that there are two harvests in every year. There is in this island a magnificent temple to Apollo, circular in form, and adorned with many splendid offerings; and there is also a city sacred to Apollo, inhabited principally by harpers who in his temple sing sacred verses to the God. . . . Once in nineteen years (and this period is what we call the great year) they say that their God visits the island, and from the Vernal Equinox to the rising of the Pleiades (about May 1) all the night through expresses his satisfaction by dances and by playing on the harp."

The first author who is considered to make unmistakable mention of Stonehenge is Henry of Huntingdon (twelfth century). He speaks of it as the second wonder in England, and calls it Stanenges. Geoffry of Monmouth (A.D. 1138) wrote of it about the same time, as did his contemporary, Giraldus Cambrensis.

Langtoft, in his chronicle, tells a curious story :—

"A wonder wit of Wiltshire, rambling to Rome to gaze at antiquities, and there screwing himself into the company of antiquarians, they intreated him to illustrate to them that famous monument in his country called 'Stonage.' His answer was that he had never seen it, whereupon they kicked him out of doors and bade him go home and see Stonehenge."

Pepys says the stones are "as prodigious as any tales I have ever heard of them, and worth going this journey to see."

Mr. E. S. Maskelyne, in a lecture read 1897, called "The Age and Purpose of Stonehenge," fixes its date as 900 or 1000 B.C. (a date which seems sufficiently nearly confirmed by recent researches). Mr. Maskelyne proceeds :—

"I should like to add some reasons for my belief that Stonehenge was built by the Phœnicians. In the first place I cannot think of any other people that could either have designed or executed such a monument, which required both science for its conception and skill for its erection. The Phœnicians, with their familiarity with masts, cordage and pulleys could easily lift the imposts, and they must have known how the Egyptians raised masses of stone many times heavier.

"The trilithon standing clear seems to have had some fascination for the Phœnicians. They are found still standing in Tripoli in Libya, and specimens exist on the continent of Europe in Normandy and Brittany. One may be seen in the island of Ushant and another in St. Nazaire on the probable route they adopted for the carriage of tin. . . .

"About B.C. 400 the Greeks supplanted the Phœnicians in their trade with Britain. . . . Stonehenge must have been a noted temple, and I cannot doubt that Hecatæus did allude to it in the sixth century B.C. as the round temple of Apollo in the land of the Hyperboreans.

"As to the kinds of stone employed in the building, the whole of the outer circle and the four stones beyond that circle are undoubtedly 'Sarsen,' which are boulders left by the ice-sheet of the Glacial period on the Wiltshire Downs. In the inner circle are four stones of *whinstone*, an impure ironstone; the remainder are syenite, commonly called bluestones, and identical with those found on Dartmoor and many parts of Devon and Cornwall, the *altar-stone* being a kind of coarse blue marble, perhaps from Derbyshire."

Stonehenge stands about 440 feet above the sea-level. The outer circle measures 308 (330 externally). These stones formerly stood 14 feet above the surface of the ground. The uprights are unhewn, but have knobs or tenons on the top which fitted into mortise-holes on the underside of the horizontal stones, which were roughly squared.

Within this peristyle was the inner circle, composed mainly of unhewn syenite obeliscs, and then the great ellipse, formed of five (but some think seven) huge trilithons, which rose progressively in height from N.E. to S.W., the loftiest uprights being 25 feet above the ground. Of these remain two perfect trilithons and two of the upright stones, but of these one is much inclined from the vertical. The fall of one of the trilithons took place in A.D. 1620, owing to some injudicious excavations

[1] 240 in the text, but from other accounts this must be an error.

of the then Duke of Buckingham. Another fell in 1797, owing to the action of the weather upon its foundations.

The entrance to Stonehenge faced the N.E., and the road to it, or "Via Sacra," called the Avenue, can be traced by banks of earth which fall into those of the circumscribing circle of the earth bank which surrounds the whole structure, and which has a diameter of about 200 feet.

Prof. W. M. Flinders Petrie's account is cited as arriving at a date very much later than that given by Mr. Maskelyne, viz. as between 500 and 900 A.D.!

Lady Antrobus' book concludes with an account of the objects met with on the picturesque road which leads from Amesbury to Salisbury along the banks of the Avon.

OUR BOOK SHELF.

Polyphem ein Gorilla. By Dr. Th. Zell. Pp. 184. (Berlin: W. Junk, 1901.) Price Mk. 2.50.

A BOOK of nearly two hundred octavo pages of close print, discussing the subject above mentioned, may, without exaggeration, be termed exhaustive. It should be at once added, however, that in his preface the author refers expressly to those of the fifteen chapters (viz. Nos. xiii and xiv) which contain the essential arguments in support of his views. Otherwise the reader should be prepared to find himself involved in the consideration of the behaviour of animals in relation to changes in the weather, or engaged in the study of the relative keenness of the special senses of the walrus. The effects of meteorological changes on animals are discussed in reference to the story, not of Polyphemus, but of Proteus, in the course of a general disquisition on the interpretation of Homeric myths, while the subject of the special senses appears in subtle connection with important questions raised by the peculiar cyclopian eye of Polyphemus. The author's enthusiasm and his desire to examine all sides of the question have led him to burden his work with a large amount of detail, which could have been largely avoided, without diminishing the value of the book, by the substitution of reference for quotation *in extenso*.

The contributions to Homeric literature consist, firstly, in the exposition of the view expressed in the title of the book, viz., that the story of Polyphemus is not, as Grimm and others believe, a mystic account of the strife of the elements or a solar myth, but rather the reminiscence of an encounter of early civilised man with a pre-human ancestor. To this ancestor Dr. Zell prefers to refer as a "gorilla-mensch," reminding one of Winwood Reade's implied suggestion that Caliban was a gorilla.

In the second place, Dr. Zell suggests that the term cyclopian indicates that the person or animal so designated had simply eyes of rounded appearance and was not necessarily the possessor of a single median organ of sight.

While agreeing with Dr. Zell that the explanation of the story of Polyphemus is to be sought in the actual adventures of early voyagers, rather than in an appeal to the unaided inventive faculty of a poet, it is thought that the term "gorilla-mensch," as well as the title of the book, are distinctly unfortunate, as tending to revive the now discarded view that the particular ape in question should be regarded as figuring in the line of human ancestry. If the large gorilla mentioned on p. 112 is that which has been recently represented in certain publications in England and Germany, it is thought that Dr. Zell has been misled; for the attitude of the specimen referred to is not warranted by the structural anatomy of the gorilla.

With regard to the explanation of the term κύκλωψ, it must be admitted that this is a subject for inquiry on the part of philologists rather than students of natural science. Two remarks may be made here. The ordinarily accepted significance is one of very ancient standing. At the same time it is far more essential to Grimm's explanation than to that of Dr. Zell. W. L. H. D.

The Evolution of Consciousness. By Leonard Hall, M.A. Pp. 152. (London: Williams and Norgate, 1901.) Price 3s. net.

THIS is one of those well-meaning but futile books which it is almost impossible to criticise. To write a history of the evolution of consciousness an author should be thoroughly well informed of the latest results in both psychology and physiology. Mr. Hall seems to depend for his knowledge of the two sciences principally on the late J. S. Mill, with an infusion of Mr. Herbert Spencer. His account of psychological development is, no doubt unconsciously, entirely at variance with the results which have been won in recent years by careful experimentation, especially in the important domains of animal psychology, the analysis of spatial perception and the investigation of the processes by which meaning is acquired. The physiological explanations in which the writer indulges most frequently amount to nothing more than the reiteration of the blessed words "integration" and "differentiation." His grand thesis is that human consciousness is the property of a dominant cell or monad, but he seems not to be aware of the practical dethronement of the cell by the neuron as the unit of nervous action, nor does he offer any valid reason for his belief that the sub-cortical and medullary cells have a minor consciousness of their own. The actual "transference of consciousness" from one cell to another of which he talks freely is, of course, nonsense. Like most writers whose knowledge of psychology is of the same kind as his own, he is a very dogmatic and determined adherent of the merely mechanical theory of human action.

The Self-Educator in Chemistry. By James Knight, M.A., B.Sc., F.C.S., F.G.S., F.E.I.S. Edited by John Adams, M.A., B.Sc. Pp. xxiv + 162. (London: Hodder and Stoughton, 1901.) Price 2s. 6d.

THE intention and hope of the series to which this book belongs is that "the most isolated student will be able, without other aid, to ground himself in the various subjects dealt with." It is much to be doubted whether Mr. Knight's book will achieve any such purpose. Grounding in a subject is usually held to mean the laying down of substantial foundations, whereas this book is calculated rather to give superficial and miscellaneous information. It will give the reader no idea of the methods by which the principles of chemistry have been established, how chemical knowledge grows, or how chemists work and think. Within the first four pages the reader is introduced to atoms and molecules, graphic formulæ and the mysteries of the nascent state, whilst on the fifth he is told, "the statement that the atomic weight of oxygen is 16, means that a cubic inch, say, of oxygen is 16 times as heavy as a cubic inch of hydrogen. The atomic weight of substances like copper and carbon, which are not gases at all, are got in a more round-about fashion."

The most that can be said for the book is that it aims at showing chemistry in its relation to the things and phenomena of daily life. But it is neither thorough nor accurate, and doubts must arise as to the claims of a populariser who, besides propounding theory in the manner illustrated above, gets so far wrong in matters of fact as, for example, to state (p. 42) that hydrogen is liberated when steam is passed over red-hot copper, and that water gas and producer gas have the same composition. A. S.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Density and Figure of Close Binary Stars.

WHEN one star revolves round another in an orbit of which the plane is coincident, or nearly so, with the line of sight, an eclipse of one star by the other will take place every revolution. We have, in such circumstances, the well-known phenomenon of Algol variation.

It is evident that the duration, extent, and nature of the eclipse will depend upon the size and brightness of the component stars, and on the magnitude, inclination, and eccentricity of the orbit in which they move.

In practice, of course, the problem is the indirect one of determining the elements of orbital movement of the system from the observed variation in the star's brightness. That is to say, having ascertained, either photometrically or photographically, the manner in which the light of the star varies, we determine the physical conditions which have produced this variation.

There is no field of astronomical research in the present day so interesting, or so rich in future possibilities, as that which deals with close binary stars. We have only to instance the recent discovery, by Prof. W. W. Campbell, of the Lick Observatory, that at least one star in every five or six is a spectroscopic binary (*Astrophysical Journal*, vol. xiii. p. 89), as an indication of the vastness of the field.

If Prof. Campbell's estimate of the number of binary systems be correct, then there ought, on the consideration that such systems may revolve in any plane, to be at least 800 Algol variables brighter than the ninth magnitude. At present only twenty-two such systems are known to astronomers.

Then, again, the certainty that in variable stars of the Algol type—that is, binary stars revolving round one another almost or *actually in* contact—we have the first stage in the evolution of a stellar system, gives a unique interest to any investigation, whether spectroscopic or photometric, which has as its purpose the delineation of the conditions of magnitude and movement of such systems.

Of the many problems intimately related to a determination of the elements of orbital movement of any close binary system, two are, I think, of peculiar interest, as bearing directly on the evolution of such systems.

(1) When we have ascertained the size and brightness of the component stars of any system, and also the form, position, and magnitude of the orbit in which they revolve, we can directly deduce the mean density of the system. A full investigation of this and allied problems is given by Mérian in *Comptes rendus* (122, 1254).

A nomenclature adopted by the present writer, in the *Astrophysical Journal* (vol. x. p. 308), meets, I think, more directly the simpler conditions of the problem of the density of a close binary star.

Putting t = time, in days, of revolution;
r = semi-axis major of the orbit of the system;
p = ratio of the radius of companion (1) to semi-axis major;
q = ratio of the radius of companion (2);
m_1 = mass of companion (1);
m_2 = mass of companion (2);
Δ_1 = density of companion (1);
Δ_2 = density of companion (2);

(the sun's radius, mass and density are taken as unity) then the simple relation

$$\Delta_1 = \frac{0\cdot0135}{p^3t^2} \cdot \frac{m_1}{m_1 + m_2}, \quad . \quad . \quad . \quad . \quad (1)$$

$$\Delta_2 = \frac{0\cdot0135}{q^3t^2} \cdot \frac{m_2}{m_1 + m_2}, \quad . \quad . \quad . \quad . \quad (2)$$

will determine the values of Δ_1 and Δ_2 when the relative masses of the two component stars are known.

If $$p = q,$$

then $$\Delta_1 + \Delta_2 = \frac{0\cdot0135}{p^3t^2}. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

It will be at once evident that, since

$$\frac{m_1}{m_1 + m_2} \text{ and } \frac{m_2}{m_1 + m_2}$$

must always be less than unity,

$$\Delta_1 < \frac{0\cdot0135}{p^3t^2};$$

$$\Delta_2 < \frac{0\cdot0135}{q^3t^2}.$$

These two relations express the limit in one direction of the density of any binary system when the size of the component stars, and the period of variation, has been ascertained from an examination of the light-curve of the variable. In the *Astrophysical Journal* (vol. x. p. 315), Prof. H. N. Russell, of the Princeton University, from considerations similar to the foregoing, deals with the light-variation of seventeen out of the twenty-two Algol variables, deducing from their variation their densities.

He finds the mean density of the seventeen stars considered to be

0·19,

the density o. water being unity.

In the same *Journal* (vol. x. p. 314), the writer discussed the light-changes of four southern Algol variables which had been under observation for some years at Lovedale, South Africa.

The mean density of these four stars was found to be 0·13 that of the sun. If the sun's density be taken as 1·44 times the density of water, then this result would yield as the mean density of the stars considered,

0·187.

Since this article was written, two new southern Algol variables have been discovered—one at the Cape Royal Observatory and the other at Lovedale. Further, a new photometric equatorial, specially constructed by Messrs. Cooke for variable star work, has made it possible to secure observations, at Lovedale, of all the eight southern Algol variables of considerable accuracy.

A reduction of these observations has just been completed, and an examination of the results gives, as the mean density of all the southern Algol variables at present known, viz. eight, the value

0·176.

Of the three investigations just given in brief, the first two were independently conceived, carried out, and completed. Yet the results are practically accordant.

There is just the barest possibility that this agreement may be fortuitous; such a remote possibility exists in all investigations.

It is much more probable, however, that the agreement between the results indicates the truth of the conclusion. And this conclusion is that the average density of close binary stars—that is, of bodies just forming, by the compulsion of their inherent forces, into a dual existence—is one-sixth that of water or one-eighth that of the sun.

It is not the purport of the present paper to follow the investigation to its legitimate termination—that is, to discover in what agreement is the result just obtained with the theoretical conditions of density consonant with a rotating ellipsoid on the limit of bipartition. A broad general agreement, however, is evident even on an elementary judgment, for if the result had been that the average density of close binary systems, or of the actual density of any one system, was, say, much greater than that of the earth, then it would be difficult to understand how separation could take place under these conditions. On the other hand, no violence is done to our appreciation of what is reasonable when we find that *all* close binary systems have a density much less than water; in some single cases, indeed, we meet with densities approaching that of a gaseous nebula. Such a condition of tenuity is evidently favourable to disruption.

Any investigation of the light-changes of an Algol variable, having extreme accuracy in view, must of necessity consider the form of the stars alternately eclipsing one another.

It is evident that the rate of decrease or increase of eclipse will be more rapid the more ellipsoidal in figure the component stars are.

In the case of two spheres eclipsing one another, the amount of obscuration, or the total amount of light emitted by the system, at any period of the eclipse, can be ascertained from the simplest geometrical considerations. In the case of two spheroids, the computation is not so simple.

Still a relation does exist between the amount of distortion due to the mutual attractions of two adjacent bodies, and the rate of obscuration in any eclipse, and this relation is capable of discernment and computation. The difficulty, however, does not lie in the computation: it lies in our inability to determine observations refined enough to respond to a demand so exacting as that which necessitates observations correct to within two-hundredths of a magnitude.

That this degree of accuracy in photometric measurement has been attained to by more than one observer brings the problem of the determination of the figure of a rotating binary system within a reasonable expectation of solution.

Of the twenty-two Algol variables at present known, five are binary systems the component stars of which revolve in contact. It is, therefore, evident that any investigation having as its purpose the figure of the component members of a close binary system should deal first with these five stars.

Particulars of these stars are as follows:—

Chandler No.	Designation.	R.A. 1900.	Decl. 1900.	Period.	Max.	Min.
		h. m. s.	° ′	d. h. m. s.	m.	m. m.
2852	V Puppis	7 55 22	−48 58·4	1 10 54 27	4·1	4·7—4·9
3055	X Carinae	8 29 7	−58 53·2	1 1 59 0	7·9	8·6—8·7
5099	RR Centauri.	14 9 55	−57 23·3	0 14 32 7	7·4	7·8—7·85
6758	β Lyræ	18 46 23	+33 14·8	12 21 46 58	3·4	3·9—4·5
8598	U Pegasi	23 52 53	+15 23·9	0 8 59 41	9·3	9·8—9·9

It may be objected that all along it has been assumed that Algol variables are binary systems. What evidence is there that this is so?

In the only cases where independent confirmation is possible—that is, in cases where the stars are bright enough to be dealt with spectroscopically—this confirmation is forthcoming.

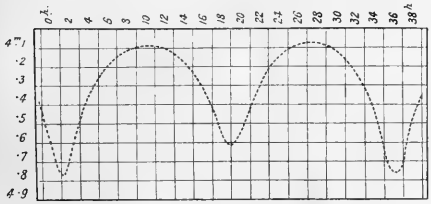


FIG. 1.—Light-curve of V Puppis, from observations made at Lovedale South Africa.

With regard to the foregoing five stars, the spectroscope reveals V Puppis and β Lyræ to be binary systems. The other stars are beyond the reach of spectroscopic examination, at least with its present limitations.

Apart from this, however, revolution and consequent eclipse is the only complete explanation of Algol variation.

In Fig. 1 is given the light-curve of V Puppis, the first star in the list, and this light-curve may be taken as typical of those of the other four stars. Indeed, the light-curve of U Pegasi (*Harvard Circular*, No. 23) is practically identical with that of V Puppis.

The figure of the β Lyræ system has been considered most fully and conclusively by Mr. Myers in the *Astrophysical Journal* (vol. vii. p. 1); one of his definite results being that each star forming the system is not a sphere but an ellipsoid of revolution. The amount of flattening is found to be 0·2 in both stars.

Mr. Myers also deals with the variation of U Pegasi in the same manner (*Astrophysical Journal*, vol. viii. p. 163), and finds that there is distinct evidence, in the form of the light-curve of this star, of an ellipsoidal figure in both components.

In the *Astrophysical Journal* (vol. xiii. p. 177), the writer considered the variation of V Puppis, the first of the five stars. Again it was found that while, to no insufficient extent, the view that the light-changes were produced by the eclipse of two spheres would meet the facts of variation, an assumption that both components were ellipsoidal in figure would satisfy the observations more fully.

Since the foregoing article was published, an examination of all the observations of X Carinæ and RR Centauri made at Lovedale has been completed. It is found that the twin stars of X Carinæ have parted company. They are no longer in actual contact, although a distance of only one-tenth of their diameters separates them. The observations of this star also do not indicate an unmistakable distortion of either component.

In the case of RR Centauri we have a twin system similar to that of V Puppis, with this difference, that the form of the light-curve indicates beyond doubt a considerable ellipsoidal form of both stars. Indeed, a dumb-bell figure of equilibrium similar to that indicated in Prof. Darwin's treatise on "Figures of Equilibrium of Rotating Masses of Fluid" (p. 429) would produce variation of the same character as that of RR Centauri.

Of the interest which attaches to all investigations, whether by telescope or spectroscope, concerning these remarkable binary systems, there can be no manner of doubt. For we are dealing with the origin of stellar systems.

Hitherto, in theory only have we had cognisance of some great gaseous orb aggregating itself into two elongated spheroids, dividing after the lapse of long ages into two separate and distinct bodies.

By the action and interaction of their tidal forces, the gap between the component stars grows wider and wider: the system ceases to be a close binary star fulfilling its period in days; it takes months to complete its circuit.

And still the apocentric revolution goes on, until, at last, the star becomes a visual binary, one component separated from its fellow by the width of the whole solar system.

From V Puppis, on the one hand, a dumb-bell system speeding round in thirty-five hours, to the twin stars of Castor, completing their great round in one thousand years, we have a regular chain of sequences in distance.

The links of this chain are made evident by observation as well as by theory. It is not unreasonable, therefore, that the present trend of astrophysical research should be in the direction of discovering more fully and certainly the different stages of evolution and development in the architecture of the heavens.

ALEX. W. ROBERTS.

Lovedale, South Africa, August 9.

A Plea for a Prehistoric Survey of Southern India.

ACCORDING to Mr. R. Bruce Foote, and no one is more competent to speak than he, the urgency for the establishment of a genuine prehistoric survey in Southern India is very great, if the study of this most fascinating branch of archæology is to be encouraged and the wanton destruction of prehistoric monuments checked. Such survey, if honestly carried out, would go far to procure much larger data than yet exist as to the distribution over the southernmost districts of the peninsula of the Palæolithic people whose remains in the shape of chipped stone implements have been found in so many localities in the Carnatic and Deccan plateau, embedded in Pleistocene deposits. Such data might help materially also to bridge over the great hiatus in time which now appears to exist between the era of those very rude people and that of the Neolithic tribes which followed them in the same country.

Further research in the southern districts especially might result in the finding of evidence as to the quarter from which the Dravidian tribes entered the Peninsula—a question of very high ethnological interest.

Another very important ethnological question might possibly be also answered by such investigations, namely, were the first Dravidian immigrants that settled in Southern India in a Neolithic stage of culture, or must the polished-stone people be considered as pre-Dravidian? If the question be answered in the latter way, a fresh immigration must be postulated, by which the true Dravidians reached their present country. If the answer affirms the former proposition, the idea of a further immigration may be dispensed with, for the early iron people appear to be the direct descendants of the Neolithic tribes and the ancestors of the present inhabitants.

Every year numbers of prehistoric burial places are destroyed by the rapacity of the "Waddars," the wandering tribe of tank diggers, who are allowed to annex the fine slabs composing the *kistvaens*, while independent archæologists are, by Government order, forbidden to open any old graves unless they are willing to make over to the Museum all their finds and bear their own expenses. The lapse of time and effects of weather greatly tend to diminish the remains of the old people in the sites they occupied. The action of the plough in many cases, and the trampling of herds of cattle in others, are active elements of destruction of pottery buried near the surface, and even of stone implements. These remarks apply with equal force to the old sites of the early iron age folk, both residential and sepulchral.

Mr. Foote further states in his "Catalogue of the Prehistoric Antiquities" in the Government Museum at Madras, that a full and exhaustive prehistoric survey of the country should be made by a really competent specialist, who shall be a geologist and an osteologist as well as a trained archæologist, and not a mere architectural surveyor. A knowledge of Sanskrit will be of no use in deciding as to the sources whence were derived the many foreign rocks and minerals found in the many old residential sites, which, up to date, have had only their surfaces examined, but which, doubtless, in many cases will yield rich finds to the careful excavator, who must be a man having the power to devote time to his work. A. C. HADDON.

Cambridge, September 3.

THE BRITISH ASSOCIATION AT GLASGOW.

IN the previous articles, which appeared in NATURE, May 23, July 18, and August 22, particulars were given as to the local arrangements for the meeting in Glasgow, and a forecast of the papers to be read at the sectional meetings was published. The president, Principal A. W. Rücker, delivered his presidential address, which we print in this issue, as we went to press yesterday, and the business of the sections commenced this morning. A large number of British leading men of science are present at the meeting, and many well-known men of science are also present from abroad. Among others, the following are attending the meeting:—Prof. L. Kny, Berlin; Prof. George Quincke, Heidelberg; Prof. G. Mittag-Leffler, Stockholm; Dr. Gustav Cassil, Copenhagen; Prof. A. F. Renard, Ghent; Prof. Gustave Gilson, Louvain; Mr. A. Laurence Rotch, Readville, Mass., U.S.A.; Prof. R. H. Thurston, Cornell University; Dr. T. P. Lotsy, Arnheim, Holland; Dr. Theodor Beer, Vienna; Prof. J. J. Mackenzie, Toronto; Prof. E. W. Morley, Cleveland, Ohio; Prof. Joji Sakurai, Tokyo; His Excellency Don Arturo de Marcoartu, Bilbao; Prof. J. P. McMurrick, Michigan; Dr. V. Crémieu, Paris; Prof. Dr. W. Marikwald, Berlin; Prof. Paul Walden, Riga; Prof. Goebel, Munich; Dr. C. E. Guillaume, Sevres; Dr. Conventz, Danzig; Baron Varilla, Paris; Mr. Edward Atkinson, Brooklyn; Prof. Anitchkoff, Russia.

The meeting promises to be a successful one, both from the point of view of numbers and that of scientific interest.

INAUGURAL ADDRESS BY PROF. ARTHUR W. RÜCKER, M.A., LL.D., D.SC., SEC.R.S., PRESIDENT OF THE ASSOCIATION.

THE first thought in the minds of all of us to-night is that since we met last year the great Queen, in whose reign nearly all the meetings of the British Association have been held, has passed to her rest.

To Sovereigns most honours and dignities come as of right; but for some of them is reserved the supreme honour of an old age softened by the love and benedictions of millions; of a path to the grave, not only magnificent, but watered by the tears both of their nearest and dearest, and of those who, at the most, have only seen them from afar.

This honour Queen Victoria won. All the world knows by what great abilities, by what patient labour, by what infinite tact and kindliness, the late Queen gained both the respect of the rulers of nations and the affection of her own subjects.

Her reign, glorious in many respects, was remarkable, outside these islands, for the growth of the Empire; within and without them, for the drawing nearer of the Crown and the people in mutual trust; while, during her lifetime, the developments of science and of scientific industry have altered the habits and the thoughts of the whole civilised world.

The representatives of science have already expressed in more formal ways their sorrow at the death of Queen Victoria, and the loyalty and confident hope for the future with which they welcome the accession of King Edward. But none the less, I feel sure that at this, the first meeting of the British Association held in his reign, I am only expressing the universal opinion of all our members when I say that no group of the King's subjects trusts more implicitly than we do in the ability, skill, and judgment which His Majesty has already shown in the exercise of the powers and duties of his august office; that none sympathise more deeply with the sorrows which two great nations have shared with their Sovereigns; and that none cry with more fervour, "Long live the King!"

But this meeting of the British Association is not only remarkable as being the first in a new reign. It is also the first in a new century. It is held in Glasgow at a time when your International Exhibition has in a special sense attracted the attention of the world to your city, and when the recent celebration of the ninth jubilee of your University has shown how deeply the prosperity of the present is rooted in the past. What wonder, then, if I take the Chair to which you have called me with some misgivings? Born and bred in the South, I am to preside over a meeting held in the largest city of Scotland. As your chosen mouthpiece I am to speak to you of science when we stand at the parting of the centuries, and when the achievements of the past and present, and the promise of the future, demand an interpreter with gifts of knowledge and divination to which I cannot pretend. Lastly, I am President of the British Association as a disciple in the home of the master, as a physicist in a city which a physicist has made for ever famous. Whatever the future may have in store for Glasgow, whether your enterprise is still to add wharf to wharf, factory to factory, and street to street, or whether some unforeseen "tide in the affairs of men" is to sweep energy and success elsewhere, fifty-three years in the history of your city will never be forgotten while civilisation lasts.

More than half a century ago, a mere lad was the first to compel the British Association to listen to the teaching of Joule, and to accept the law of the conservation of energy. Now, alike in the most difficult mathematics and in the conception of the most ingenious apparatus, in the daring of his speculations and in the soundness of his engineering, William Thomson, Lord Kelvin, is regarded as a leader by the science and industry of the whole world.

It is the less necessary to dwell at length upon all that he has done, for Lord Kelvin has not been without honour in his own country. Many of us, who meet here to-night, met last in Glasgow when the University and City had invited representatives of all nations to celebrate the Jubilee of his professorship. For those two or three days learning was surrounded with a pomp seldom to be seen outside a palace. The strange middle-age costumes of all the chief Universities of the world were jostling here, the outward signs that those who were themselves distinguished in the study of Nature had gathered to do honour to one of the most distinguished of them all.

Lord Kelvin's achievements were then described in addresses in every tongue, and therefore I will only remind you that we, assembled here to-night, owe him a heavy debt of gratitude; for the fact that the British Association enters on the twentieth century conscious of a work to do and of the vigour to do it is largely due to his constant presence at its meetings and to the support he has so ungrudgingly given. We have learned to know, not only the work of our great leader, but the man himself; and I count myself happy because in his life-long home, under the walls of the University he served so well, and at a meeting of the Association which his genius has so often illuminated, I am allowed, as your President, to assure him in your name of the admiration, respect, nay, of the affection, in which we all hold him.

I have already mentioned a number of circumstances which make our meeting this year noteworthy; to these I must add that for the first time we have a Section for Education, and the importance of this new departure, due largely to the energy of Prof. Armstrong, is emphasised by the fact that the Chair of that Section will be occupied by the Vice-President of the Committee of Council on Education—Sir John Gorst. I will not attempt to forecast the proceedings of the new Section. Education is passing through a transitional stage. The recent debates in Parliament; the great gifts of Mr. Carnegie; the discussion as to University organisation in the North of England; the reconstitution of the University of London; the increasing importance attached to the application of knowledge both to the investigation of Nature and to the purposes of industry, are all evidence of the growing conviction that without advance in education we cannot retain our position among the nations of the world. If the British Association can provide a platform on which these matters may be discussed in a scientific but practical spirit, free from the misrepresentations of the hustings and the exaggerations of the partisan, it will contribute in no slight measure to the national welfare.

But amid the old and new activities of our meeting the undertone of sadness, which is never absent from such gatherings, will be painfully apparent to many of us at Glasgow. The life-work of Prof. Tait has ended amid the gloom of the war-cloud. A bullet, fired thousands of miles away, struck him to the heart, so that in their deaths the father and the brave son, whom he loved so well, were not long divided. Within the last year, too, America has lost Rowland; Viriamu Jones, who did yeoman's service for education and for science, has succumbed to a long and painful illness; and one who last year at Bradford seconded the proposal that I should be your President at Glasgow, and who would unquestionably have occupied this Chair before long had he been spared to do so, has unexpectedly been called away. A few months ago we had no reason to doubt that George Francis FitzGerald had many years of health and work before him. He had gained in a remarkable way not only the admiration of the scientific world, but the affection of his friends, and we shall miss sadly one whom we all cared for, and who, we hoped, might yet add largely to the achievements which had made him famous.

The Science of the Nineteenth Century.

Turning from these sad thoughts to the retrospect of the century which has so lately ended, I have found it to be impossible to free myself from the influence of the moment and to avoid, even if it were desirable to avoid, the inclination to look backward from the standpoint of to-day.

Two years ago Sir Michael Foster dealt with the work of the century as a whole. Last year Sir William Turner discussed in greater detail the growth of a single branch of science. A third and humbler task remains, viz., to fix our attention on some of the hypotheses and assumptions on which the fabric of modern theoretical science has been built, and to inquire whether the foundations have been so "well and truly" laid that they may be trusted to sustain the mighty superstructure which is being raised upon them.

The moment is opportune. The three chief conceptions which for many years have dominated physical as distinct from biological science have been the theories of the existence of atoms, of the mechanical nature of heat, and of the existence of the ether.

Dalton's atomic theory was first given to the world by a Glasgow professor—Thomas Thomson—in the year 1807, Dalton having communicated it to him in 1804. Rumford's and Davy's experiments on the nature of heat were published in 1798 and 1799 respectively; and the celebrated Bakerian Lecture, in which Thomas Young established the undulatory theory by explaining the interference of light, appeared in the *Philosophical Transactions* in 1801. The keynotes of the physical science of the nineteenth century were thus struck, as the century began, by four of our fellow-countrymen, one of whom—Sir Benjamin Thompson, Count Rumford—preferred exile from the land of his birth to the loss of his birthright as a British citizen.

Doubts as to Scientific Theories.

It is well known that of late doubts have arisen as to whether the atomic theory, with which the mechanical theory of heat is closely bound up, and the theory of the existence of an ether have not served their purpose, and whether the time has not come to reconsider them.

The facts that Prof. Poincaré, addressing a congress of physicists in Paris, and Prof. Poynting, addressing the Physical Section of the Association, have recently discussed the true meaning of our scientific methods of interpretation; that Dr. James Ward has lately delivered an attack of great power on many positions which eminent scientific men have occupied; and that the approaching end of the nineteenth century led Prof. Haeckel to define in a more popular manner his own very definite views as to the solution of the "Riddle of the Universe," are perhaps a sufficient justification of an attempt to lay before you the difficulties which surround some of these questions.

To keep the discussion within reasonable limits, I shall illustrate the principles under review by means of the atomic theory, with comparatively little reference to the ether, and we may also at first confine our attention to inanimate objects.

The Construction of a Model of Nature.

A natural philosopher, to use the old phrase, even if only possessed of the most superficial knowledge, would attempt to bring some order into the results of his observation of Nature by grouping together statements with regard to phenomena which are obviously related. The aim of modern science goes far beyond this. It not only shows that many phenomena are related which at first sight have little or nothing in common, but, in so doing, also attempts to explain the relationship.

Without spending time on a discussion of the meaning of the word "explanation," it is sufficient to say that our efforts to establish relationships between phenomena often take the form of attempting to prove that, if a limited number of assumptions are granted as to the constitution of matter, or as to the existence of quasi-material entities, such as caloric, electricity, and the ether, a wide range of observed facts falls into order as a necessary consequence of the assumptions. The question at issue is whether the hypotheses which are at the base of the scientific theories now most generally accepted are to be regarded as accurate descriptions of the constitution of the universe around us, or merely as convenient fictions.

Convenient fictions be it observed, for even if they are fictions they are not useless. From the practical point of view it is a matter of secondary importance whether our theories and assumptions are correct, if only they guide us to results which are in accord with facts. The whole fabric of scientific theory may be regarded merely as a gigantic "aid to memory"; as a means for producing apparent order out of disorder by codifying the observed facts and laws in accordance with an artificial system, and thus arranging our knowledge under a comparatively small number of heads. The simplification introduced by a scheme which, however imperfect it may be, enables us to argue from a few first principles, makes theories of practical use. By means of them we can foresee the results of combinations of causes which would otherwise elude us. We can predict future events, and can even attempt to argue back from the present to the unknown past.

But it is possible that these advantages might be attained by means of axioms, assumptions, and theories based on very false ideas. A person who thought that a river was really a streak of blue paint might learn as much about its direction from a map as one who knew it as it is. It is thus conceivable that we might be able, not indeed to construct, but to imagine, something more than a mere map or diagram, something which might even be called a working model of inanimate objects, which was nevertheless very unlike the realities of Nature. Of course, the agreement between the action of the model and the behaviour of the things it was designed to represent would probably be imperfect, unless the one were a facsimile of the other; but it is conceivable that the correlation of natural phenomena could be imitated, with a large measure of success, by means of an imaginary machine, which shared with a map or diagram the characteristic that it was in many ways unlike the things it represented, but might be compared to a model in that the behaviour of the things represented could be predicted from that of the corresponding parts of the machine.

We might even go a step further. If the laws of the working of the model could be expressed by abstractions, as, for example, by mathematical formulæ, then, when the formulæ were obtained, the model might be discarded, as probably unlike that which it was made to imitate, as a mere aid in the construction of equations, to be thrown aside when the perfect structure of mathematical symbols was erected.

If this course were adopted, we should have given up the attempt to know more of the nature of the objects which surround us than can be gained by direct observation, but might nevertheless have learned how these objects would behave under given circumstances.

We should have abandoned the hope of a physical explanation of the properties of inanimate Nature, but should have secured a mathematical description of her operations.

There is no doubt that this is the easiest path to follow. Criticism is avoided if we admit from the first that we cannot go below the surface; cannot know anything about the constitution of material bodies; but must be content with formulating a description of their behaviour by means of laws of Nature expressed by equations.

But if this is to be the end of the study of Nature, it is evident that the construction of the model is not an essential part of the process. The model is used merely as an aid to thinking; and if the relations of phenomena can be investigated without it, so much the better. The highest form of theory—it may be said—the widest kind of generalisation, is that which has given up the attempt to form clear mental pictures of the constitution of matter, which expresses the facts and the laws by language and symbols which lead to results that are true, whatever be our view as to the real nature of the objects with which we deal. From this point of view the atomic theory becomes not so much false as unnecessary; it may be regarded as an attempt to give an unnatural precision to ideas which are and must be vague.

Thus, when Rumford found that the mere friction of metals produced heat in unlimited quantity, and argued that heat was therefore a mode of motion, he formed a clear mental picture of what he believed to be occurring. But his experiments may be quoted as proving only that energy can be supplied to a body in indefinite quantity, and when supplied by doing work against friction it appears in the form of heat.

By using this phraseology we exchange a vivid conception of moving atoms for a colourless statement as to heat energy, the real nature of which we do not attempt to define; and methods which thus evade the problem of the nature of the things which the symbols in our equations represent have been prosecuted with striking success, at all events within the range of a limited class of phenomena. A great school of chemists, building upon the thermodynamics of Willard Gibbs and the intuition of Van t' Hoff, have shown with wonderful skill that, if a sufficient number of the data of experiment are assumed, it is possible, by the aid of thermodynamics, to trace the form of the relations between many physical and chemical phenomena without the help of the atomic theory.

But this method deals only with matter as our coarse senses know it; it does not pretend to penetrate beneath the surface.

It is therefore with the greatest respect for its authors, and with a full recognition of the enormous power of the weapons employed, that I venture to assert that the exposition of such a system of tactics cannot be regarded as the last word of science in the struggle for the truth.

Whether we grapple with them, or whether we shirk them; however much or however little we can accomplish without answering them, the questions still force themselves upon us: Is matter what it seems to be? Is interplanetary space full or empty? Can we argue back from the direct impressions of our senses to things which we cannot directly perceive; from the phenomena displayed by matter to the constitution of matter itself?

It is these questions which we are discussing to-night, and we may therefore, as far as the present address is concerned, put aside, once for all, methods of scientific exposition in which an attempt to form a mental picture of the constitution of matter is practically abandoned, and devote ourselves to the inquiries whether the effort to form such a picture is legitimate, and whether we have any reason to believe that the sketch which science has already drawn is to some extent a copy, and not a mere diagram, of the truth.

Successive Steps in the Analysis of Matter.

In dealing, then, with the question of the constitution of matter and the possibility of representing it accurately, we may grant at once that the ultimate nature of things is, and must remain, unknown; but it does not follow that immediately below the complexities of the superficial phenomena which affect our senses there may not be a simpler machinery of the existence of which we can obtain evidence, indirect indeed, but conclusive.

The fact that the apparent unity which we call the atmosphere can be resolved into a number of different gases is admitted; though the ultimate nature of oxygen, nitrogen, argon, carbonic acid, and water vapour is as unintelligible as that of air as a whole, so that the analysis of air may be said to have substituted many incomprehensibles for one.

Nobody, however, looks at the question from this point of view. It is recognised that an investigation into the proximate constitution of things may be useful and successful, even if their ultimate nature is beyond our ken.

Nor need the analysis stop at the first step. Water vapour and carbonic acid, themselves constituents of the atmosphere, are in turn resolved into their elements, hydrogen, oxygen, and carbon, which, without a formal discussion of the criteria of reality, we may safely say are as real as air itself.

Now, at what point must this analysis stop if we are to avoid crossing the boundary between fact and fiction? Is there any fundamental difference between resolving air into a mixture of gases and resolving an elementary gas into a mixture of atoms and ether?

There are those who cry halt! at the point at which we divide a gas into molecules, and their first objection seems to be that molecules and atoms cannot be directly perceived, cannot be seen or handled, and are mere conceptions, which have their uses, but cannot be regarded as realities.

It is easiest to reply to this objection by an illustration.

The rings of Saturn appear to be continuous masses separated by circular rifts. This is the phenomenon which is observed through a telescope. By no known means can we ever approach or handle the rings; yet everybody who understands the evidence now believes that they are not what they appear to be, but consist of minute moonlets, closely packed indeed, but separate the one from the other.

In the first place, Maxwell proved mathematically that if a Saturnian ring were a continuous solid or fluid mass it would be unstable and would necessarily break into fragments. In the next place, if it were possible for the ring to revolve like a solid body, the inmost parts would move slowest, while a satellite moves faster the nearer it is to a planet. Now, spectroscopic observation, based on the beautiful method of Sir W. Huggins, shows not only that the inner portions of the ring move the more rapidly, but that the actual velocities of the outer and inner edges are in close accord with the theoretical velocities of satellites at like distances from the planet.

This and a hundred similar cases prove that it is possible to obtain convincing evidence of the constitution of bodies between whose separate parts we cannot directly distinguish, and I take it that a physicist who believes in the reality of atoms thinks that he has as good reason for dividing an apparently continuous gas into molecules as he has for dividing the apparently continuous Saturnian rings into satellites. If he is wrong, it is not the fact that molecules and satellites alike cannot be handled and cannot be seen as individuals, that constitutes the difference between the two cases.

It may, however, be urged that atoms and the ether are alleged to have properties different from those of matter in bulk, of which alone our senses take direct cognisance, and that therefore it is impossible to prove their existence by evidence of the same cogency as that which may prove the existence of a newly discovered variety of matter or of a portion of matter too small or too distant to be seen.

This point is so important that it requires full discussion, but in dealing with it, it is necessary to distinguish carefully between the validity of the arguments which support the earlier and more fundamental propositions of the theory; and the evidence brought forward to justify mere speculative applications of its doctrines which might be abandoned without discarding the theory itself. The proof of the theory must be carried out step by step.

The first step is concerned wholly with some of the most general properties of matter, and consists in the proof that those properties are either absolutely unintelligible, or that, in the case of matter of all kinds, we are subject to an illusion similar to that the results of which we admit in the case of Saturn's rings, clouds, smoke, and a number of similar instances. The believer in the atomic theory asserts that matter exists in a particular state; that it consists of parts which are separate and distinct the one from the other, and as such are capable of independent movements.

Up to this point no question arises as to whether the separate parts are, like grains of sand, mere fragments of matter; or whether, though they are the bricks of which matter is built, they have, as individuals, properties different from those of masses of matter large enough to be directly perceived. If they are mere fragments of ordinary matter, they cannot be used as aids in explaining those qualities of matter which they themselves share.

We cannot explain things by the things themselves. If it be true that the properties of matter are the product of an underlying machinery, that machinery cannot itself have the properties which it produces, and must, to that extent at all events, differ from matter in bulk as it is directly presented to the senses.

If, however, we can succeed in showing that if the separate parts have a limited number of properties (different, it may be, from those of matter in bulk), the many and complicated properties of matter can, to a considerable extent, be explained as consequences of the constitution of these separate parts; we shall have succeeded in establishing, with regard to quantitative properties, a simplification similar to that which the chemist has established with regard to varieties of matter. The many will have been reduced to the few.

The proofs of the physical reality of the entities discovered by means of the two analyses must necessarily be different. The chemist can actually produce the elementary constituents into which he has resolved a compound mass. No physicist or chemist can produce a single atom separated from all its fellows, and show that it possesses the elementary qualities he assigns to it. The cogency of the evidence for any suggested constitution of atoms must vary with the number of facts which the hypothesis that they possess that constitution explains.

Let us take, then, two steps in their proper order, and inquire, first, whether there is valid ground for believing that all matter is made up of discrete parts; and secondly, whether we can have any knowledge of the constitution or properties which those parts possess.

The Coarse-grainedness of Matter.

Matter in bulk appears to be continuous. Such substances as water or air appear to the ordinary observer to be perfectly uniform in all their properties and qualities, in all their parts.

The hasty conclusion that these bodies are really uniform is, nevertheless, unthinkable.

In the first place, the phenomena of diffusion afford conclusive proof that matter when apparently quiescent is in fact in a state of internal commotion. I need not recapitulate the familiar evidence to prove that gases and many liquids when placed in communication interpenetrate or diffuse into each other; or that air, in contact with a surface of water, gradually becomes laden with water vapour, while the atmospheric gases in turn mingle with the water. Such phenomena are not exhibited by liquids and gases alone, or by solids at high temperatures only. Sir W. Roberts-Austen has placed pieces of gold and lead in contact at a temperature of 18° C. After four years the gold had travelled into the lead to such an extent that not only were the two metals united, but, on analysis, appreciable quantities of the gold were detected even at a distance of more than 5 millimetres from the common surface, while within a distance of three-quarters of a millimetre from the surface gold had penetrated into the lead to the extent of 1 oz. 6 dwts. per ton, an amount which could have been profitably extracted.

Whether it is or is not possible to devise any other intelligible account of the cause of such phenomena, it is certain that a simple and adequate explanation is found in the hypothesis that matter consists of discrete parts in a state of motion, which can penetrate into the spaces between the corresponding parts of surrounding bodies.

The hypothesis thus framed is also the only one which affords a rational explanation of other simple and well-known facts. If matter is regarded as a continuous medium, the phenomena of expansion are unintelligible. There is, apparently, no limit to the expansion of matter, or, to fix our attention on one kind of matter, let us say to the expansion of a gas; but it is inconceivable that a continuous material which fills or is present in every part of a given space could also be present in every part of a space a million times as great. Such a statement might be made of a mathematical abstraction; it cannot be true of any real substance or thing. If, however, matter consists of discrete particles, separated from each other either by empty space or by something different from themselves, we can at once understand that expansion and contraction may be nothing more than the mutual separation or approach of these particles.

Again, no clear mental picture can be formed of the phenomena of heat unless we suppose that heat is a mode of motion. In the words of Rumford, it is "extremely difficult, if not quite impossible, to form any distinct idea of anything capable of being excited and communicated in the manner the heat was excited and communicated in [his] experiment [on friction] except it be motion" (*Phil. Trans.*, 1798, p. 99). And if heat be motion there can be no doubt that it is the fundamental particles of matter which are moving. For the motion is not visible, is not motion of the body as a whole, while diffusion, which is a movement of matter, goes on more quickly as the temperature rises, thereby proving that the internal motions have become more rapid, which is exactly the result which would follow if these were the movements which constitute sensible heat.

Combining, then, the phenomena of diffusion, expansion, and heat, it is not too much to say that no hypotheses which make them intelligible have ever been framed other than those which are at the basis of the atomic theory.

Many other considerations also point to the same conclusion. Many years ago Lord Kelvin gave independent arguments, based on the properties of gases, on the constitution of the surfaces of liquids, and on the electric properties of metals, all of which indicate that matter is, to use his own phrase, coarse-grained—that it is not identical in constitution throughout, but that adjacent minute parts are distinguishable from each other by being either of different natures or in different states.

And here it is necessary to insist that all these fundamental proofs are independent of the nature of the particles or granules into which matter must be divided.

The particles, for instance, need not be different in kind from the medium which surrounds and separates them. It would suffice if they were what may be called singular parts of the medium itself, differing from the rest only in some peculiar state of internal motion or of distortion, or by being in some other way earmarked as distinct individuals. The view that the constitution of matter is atomic may and does receive support from theories in which definite assumptions are made as to the constitution of the atoms; but when, as is often the case, these assumptions introduce new and more recondite difficulties, it must be remembered that the fundamental hypothesis—that matter consists of discrete parts, capable of independent motions—is forced upon us by facts and arguments which are altogether independent of what the nature and properties of these separate parts may be.

As a matter of history, the two theories, which are not by any means mutually exclusive, that atoms are particles which can be treated as distinct in kind from the medium which surrounds them, and that they are parts of that medium existing in a special state, have both played a large part in the theoretical development of the atomic hypothesis. The atoms of Waterston, Clausius, and Maxwell were particles. The vortex-atoms of Lord Kelvin, and the strain-atoms (if I may call them so) suggested by Mr. Larmor, are states of a primary medium which constitutes a physical connection between them, and through which their mutual actions arise and are transmitted.

Properties of the Basis of Matter.

It is easy to show that, whichever alternative be adopted, we are dealing with something, whether we consider it under the guise of separate particles or of differentiated portions of the medium, which has properties different from those of matter in bulk.

For if the basis of matter had the same constitution as matter, the irregular heat movements could hardly be maintained either against the viscosity of the medium or the frittering away of energy of motion which would occur during the collisions between the particles. Thus, even in the case in which a hot body is prevented from losing heat to surrounding objects, its sensible heat should spontaneously decay by a process of self-cooling. No such phenomenon is known, and though on this, as on all other points, the limits of our knowledge are fixed by the uncertainty of experiment, we are compelled to admit that, to all appearance, the fundamental medium, if it exists, is unlike a material medium, in that it is non-viscous; and that the particles, if they exist, are so constituted that energy is not frittered away when they collide. In either case, we are dealing with something different from matter itself in the sense that, though it is the basis of matter, it is not identical in all its properties with matter.

The idea therefore that entities exist possessing properties different from those of matter in bulk is not introduced at the end of a long and recondite investigation to explain facts with which none but experts are acquainted. It is forced upon us at the very threshold of our study of Nature. Either the properties of matter in bulk cannot be referred to any simpler structure, or that simpler structure must have properties different from those of matter in bulk as we directly knew it—properties which can only be inferred from the results which they produce.

No *a priori* argument against the possibility of our discovering the existence of quasi-material substances, which are nevertheless different from matter, can prove the negative proposition that such substances cannot exist. It is not a self-evident truth that no substance other than ordinary matter can have an existence as real as that of matter itself. It is not axiomatic that matter cannot be composed of parts whose properties are different from those of the whole. To assert that even if such substances and such parts exist no evidence however cogent could convince us of their existence is to beg the whole question at issue; to decide the cause before it has been heard.

We must therefore adhere to the standpoint adopted by most scientific men, viz., that the question of the existence of ultra-physical entities, such as atoms and the ether, is to be settled by the evidence, and must not be ruled out as inadmissible on *a priori* grounds.

On the other hand, it is impossible to deny that, if the mere entry on the search for the concealed causes of physical phenomena is not a trespass on ground we have no right to explore, it is at all events the beginning of a dangerous journey.

The wraiths of phlogiston, caloric, luminiferous corpuscles, and a crowd of other phantoms haunt the investigator, and as the grim host vanishes into nothingness he cannot but wonder if his own conceptions of atoms and of the ether

> "shall dissolve,
> And, like this insubstantial pageant faded,
> Leave not a wrack behind."

But though science, like Bunyan's hero, has sometimes had to pass through the "Valley of Humiliation," the spectres which meet it there are not really dangerous if they are boldly faced. The facts that mistakes have been made, that theories have been propounded, and for a time accepted, which later investigations have disproved, do not necessarily discredit the method adopted. In scientific theories, as in the world around us, there is a survival of the fittest, and Dr. James Ward's unsympathetic account of the blunders of those whose work, after all, has shed glory on the nineteenth century, might *mutatis mutandis* stand for a description of the history of the advance of civilisation. "The story of the progress so far," he tells us, "is briefly this: Divergence between theory and fact one part of the way, the wreckage of abandoned fictions for the rest, and an unattainable goal of phenomenal nihilism and ultra-physical mechanism beyond" ("Naturalism and Agnosticism," vol. i. p. 153).

"The path of progress," says Prof. Karl Pearson, "is strewn with the wreck of nations. Traces are everywhere to be seen of the hecatombs of inferior races, and of victims who found not the narrow way to the greater perfection. Yet these dead peoples are, in very truth, the stepping-stones on which mankind has arisen to the higher intellectual and deeper emotional life of to-day" ("National Life from the Standpoint of Science," p. 62).

It is only necessary to add that the progress of society is directed towards an unattainable goal of universal contentment, to make the parallel complete.

And so, in the one case as in the other, we may leave "the dead to bury their dead." The question before us is not whether we too may not be trusting to false ideas, erroneous experiments, evanescent theories. No doubt we are; but, without making an insolent claim to be better than our fathers, we may fairly contend that, amid much that is uncertain and temporary, some of the fundamental conceptions, some of the root-ideas of science, are so grounded on reason and fact that we cannot but regard them as an aspect of the very truth.

Enough has, perhaps, now been said on this point for my immediate purpose. The argument as to the constitution of matter could be developed further in the manner I have hitherto adopted, viz. by series of propositions, the proof of each of which is based upon a few crucial phenomena. In particular, if matter is divided into moving granules or particles, the phenomenon of cohesion proves that there must be mutual actions between them analogous to those which take place between large masses of matter, and which we ascribe to force, thereby indicating the regular, unvarying operation of active machinery which we have not yet the means of adequately understanding. For the moment, I do not wish to extend the line of reasoning that has been followed. My main object is to show that the notion of the existence of ultra-physical entities and the leading outlines of the atomic theory are forced upon us at the beginning of our study of Nature, not only by *a priori* considerations, but in the attempt to comprehend the results of even the simplest observation. These outlines cannot be effaced by the difficulties which undoubtedly arise in filling up the picture. The cogency of the proof that matter is coarse-grained is in no way affected by the fact that we may have grave doubts as to the nature of the granules. Nay, it is of the first importance to recognise that, though the fundamental assumptions of the atomic theory receive overwhelming support from a number of more detailed arguments, they are themselves almost of the nature of axioms, in that the simplest phenomena are unintelligible if they are abandoned.

The Range of the Atomic Theory.

It would be most unfair, however, to the atomic theory to represent it as depending on one line of reasoning only, or to treat its evidence as bounded by the very general propositions I have discussed.

It is true that as the range of the theory is extended the fundamental conception that matter is granular must be expanded and filled in by supplementary hypotheses as to the constitution of the granules. It may also be admitted that no complete or wholly satisfactory description of that constitution can as yet be given; that perfection has not yet been attained here or in any other branch of science; but the number of facts which can be accounted for by the theory is very large compared with the number of additional hypotheses which are introduced; and the cumulative weight of the additional evidence obtained by the study of details is such as to add greatly to the strength of the conviction that, in its leading outlines, the theory is true.

It was originally suggested by the facts of chemistry, and though, as we have seen, a school of chemists now thrusts it into the background, it is none the less true, in the words of Dr. Thorpe, that "every great advance in chemical knowledge during the last ninety years finds its interpretation in [Dalton's] theory" ("Essays on Historical Chemistry," 1894, p. 368).

The principal mechanical and thermal properties of gases have been explained, and in large part discovered, by the aid of the atomic theory; and, though there are outstanding difficulties, they are, for the most part, related to the nature of the atoms and molecules, and do not affect the question as to whether they exist.

The fact that different kinds of light all travel at the same speed in interplanetary space, while they move at different rates in matter, is explained if matter is coarse-grained. But to attempt to sum up all this evidence would be to recite a text-book on physics. It must suffice to say that it is enormous in extent and varied in character, and that the atomic theory imparts a unity to all the physical sciences which has been attained in no other way.

I must, however, give a couple of instances of the wonderful success which has been achieved in the explanation of physical phenomena by the theory we are considering, and I select them because they are in harmony with the line of argument I have been pursuing.

When a piece of iron is magnetised, its behaviour is different according as the magnetic force applied to it is weak, moderate, or strong. When a certain limit is passed, the iron behaves as a non-magnetic substance to all further additions of magnetic force. With strong forces it does and with very weak forces it does not remain magnetised when the force ceases to act. Prof. Ewing has imitated all the minute details of these complicated properties by an arrangement of small isolated compass needles to represent the molecules. It may fairly be said that as far as this particular set of phenomena is concerned a most instructive working model based on the molecular theory has not only been imagined but constructed.

The next illustration is no less striking. We may liken a crowd of molecules to a fog; but while the fog is admitted by everybody to be made up of separate globules of water, the critics of scientific method are sometimes apt to regard the molecules as mere fictions of the imagination. If, however, we could throw the molecules of a highly rarefied gas into such a state that vapour condensed on them, so that each became the centre of a water-drop, till the host of invisible molecules was, as it were, magnified by accretion into a visible mist, surely no stronger proof of their reality could be desired. Yet there is every reason to believe that something very like this has been accomplished by Mr. C. T. R. Wilson and Prof. J. J. Thomson.

It is known that it is comparatively difficult to produce a fog in damp air if the mixture consists of air and water-vapour alone. The presence of particles of very fine dust facilitates the process. It is evident that the vapour condenses on the dust particles, and that a nucleus of some kind is necessary on which each drop may form. But electrified particles also act as nuclei; for if a highly charged body from which electricity is escaping be placed near a steam jet, the steam condenses; and a cloud is also formed in dust-free air more easily than would otherwise be the case if electricity is discharged into it.

Again, according to accepted theory, when a current of electricity flows through a gas, some of the atoms are divided into parts which carry positive and negative charges as they move in opposite directions, and unless this breaking-up occurs a gas does not conduct electricity. But a gas can be made a conductor merely by allowing the Röntgen rays or the radiation given off by uranium to fall upon it. A careful study of the facts shows that it is probable that some of the atoms have been broken up by the radiation, and that their oppositely electrified parts are scattered among their unaltered fellows. Such a gas is said to be ionised.

Thus by these two distinct lines of argument we come to the conclusions:—1st, that the presence of electrified particles promotes the formation of mist, and 2nd, that in an ionised gas such electrified particles are provided by the breaking-up of atoms.

The two conclusions will mutually support each other if it can be shown that a mist is easily formed in ionised air. This was tested by Mr. Wilson, who showed that in such air mist is formed as though nuclei were present, and thus in the cloud we have visible evidence of the presence of the divided atoms. If, then, we cannot handle the individual molecules, we have at least some reason to believe that a method is known of seizing individuals, or parts of individuals, which are in a special state, and of wrapping other matter round them till each one is the centre of a discrete particle of a visible fog.

I have purposely chosen this illustration, because the explanation is based on a theory—that of ionisation—which is at present subjected to hostile criticism. It assumes that an electrical current is nothing more than the movement of charges of electricity. But magnets placed near to an electric current tend to set themselves at right angles to its direction; a fact on which the construction of telegraphic instruments is based. Hence if the theory be true, a similar effect ought to be produced by a moving charge of electricity. This experiment was tried many years ago in the laboratory of Helmholtz by Rowland, who caused a charged disc to spin rapidly near a magnet. The result was in accord with the theory; the magnet moved as though acted upon by an electric current. Of late, however, M. Crémieu has investigated the matter afresh, and has obtained results which, according to his interpretation, were inconsistent with that of Rowland.

M. Crémieu's results are already the subject of controversy,[1] and are, I believe, likely to be discussed in the Section of Physics. This is not the occasion to enter upon a critical discussion of the question at issue, and I refer to it only to point out that though, if M. Crémieu's result were upheld, our views as to electricity would have to be modified, the foundations of the atomic theory would not be shaken.

It is, however, from the theory of ions that the most far-reaching speculations of science have recently received unexpected support. The dream that matter of all kinds will some day be proved to be fundamentally the same has survived many shocks. The opinion is consistent with the great generalisation that the properties of elements are a periodic function of their atomic weights. Sir Norman Lockyer has long been a prominent exponent of the view that the spectra of the stars indicate the reduction of our so-called elements to simpler forms, and now Prof. J. J. Thomson believes that we can break off from an atom a part, the mass of which is not more than one-thousandth of the whole, and that these corpuscles, as he has named them, are the carriers of the negative charge in an electric current. If atoms are thus complex, not only is the *a priori* probability increased that the different structures which we call elements may all be built of similar bricks, but the discovery by Lenard

[1] See *Phil. Mag.*, July 1901, p. 144; and *Johns Hopkins University Circulars*, xx. No. 152, May–June 1901, p. 78.

that the ease with which the corpuscles penetrate different bodies depends only on the density of the obstacles, and not on their chemical constitution, is held by Prof. Thomson to be "a strong confirmation of the view that the atoms of the elementary substances are made up of simpler parts, all of which are alike."[1] On the present occasion, however, we are occupied rather with the foundations than with these ultimate ramifications of the atomic theory; and having shown how wide its range is, I must, to a certain extent, retrace my steps and return to the main line of my argument.

The Properties of Atoms and Molecules.

For if it be granted that the evidence that matter is coarse-grained and is formed of separate atoms and molecules is too strong to be resisted, it may still be contended that we can know little or nothing of the sizes and properties of the molecules.

It must be admitted that, though the fundamental postulates are always the same, different aspects of the theory, which have not in all cases been successfully combined, have to be developed when it is applied to different problems; but in spite of thi there is little doubt that we have some fairly accurate knowledge of molecular motions and magnitudes.

If a liquid is stretched into a very thin film, such as a soap-bubble, we should expect indications of a change in its properties when the thickness of the film is not a very large multiple of the average distance between two neighbouring molecules. In 1890 Sohncke (*Wied. Ann.*, 1890, xl. pp. 345–355) detected evidence of such a change in films of the average thickness of 106 millionths of a millimetre ($\mu\mu$), and quite recently Rudolph Weber found it in an oil-film when the thickness was 115 $\mu\mu$ (*Annalen der Physik*, 1901, iv. pp. 706–721).

Taking the mean of these numbers and combining the results of different variants of the theory, we may conclude that a film should become unstable and tend to rupture spontaneously somewhere between the thicknesses of 110 and 55 $\mu\mu$, and Prof. Reinold and I found by experiment that this instability is actually exhibited between the thicknesses of 96 and 45 $\mu\mu$ (*Phil. Trans.*, 1893, 184, pp. 505–529). There can therefore be little doubt that the first approach to molecular magnitudes is signalled when the thickness of a film is somewhat less than 100 $\mu\mu$, or 4 millionths of an inch.

Thirteen years ago I had the honour of laying before the Chemical Society a *résumé* of what was then known on these subjects (*Chem. Soc. Trans.*, liii., March 1888, pp. 222–262), and I must refer to that lecture or to the most recent edition of O. E. Meyer's work on the kinetic theory of gases ("Kinetic Theory of Gases," O. E. Meyer, 1899; translated by R. E. Baynes) for the evidence that various independent lines of argument enable us to estimate quantities very much less than 4 millionths of an inch, which is perhaps from 500 to 1000 times greater than the magnitude which, in the present state of our knowledge, we can best describe as the diameter of a molecule.

Confining our attention, however, to the larger quantities, I will give one example to show how strong is the cumulative force of the evidence as to our knowledge of the magnitudes of molecular quantities.

We have every reason to believe that though the molecules in a gas frequently collide with each other, yet in the case of the more perfect gases the time occupied in collisions is small compared with that in which each molecule travels undisturbed by its fellows. The average distance travelled between two successive encounters is called the mean free path, and, for the reason just given, the question of the magnitude of this distance can be attacked without any precise knowledge of what a molecule is, or of what happens during an encounter.

Thus the mean free path can be determined, by the aid of the theory, either from the viscosity of the gas or from the thermal conductivity. Using figures given in the latest work on the subject (Meyer's "Kinetic Theory of Gases"; see above), and dealing with one gas only, as a fair sample of the rest, the lengths of the mean free path of hydrogen as determined by these two independent methods differ only by about 3 per cent. Further, the mean of the values which I gave in the lecture already referred to differed only by about 6 per cent. from the best modern result, so that no great change has been introduced during the last thirteen years.

[1] For the most recent account of this subject see an article on "Bodies Smaller than Atoms," by Prof. J. J. Thomson in the *Popular Science Monthly* (The Science Press), August 1901.

It may, however, be argued that these concordant values are all obtained by means of the same theory, and that a common error may affect them all. In particular, some critics have of late been inclined to discredit the atomic theory by pointing out that the strong statements which have sometimes been made as to the equality, among themselves, of atoms or molecules of the same kind may not be justified, as the equality may be that of averages only, and be consistent with a considerable variation in the sizes of individuals.

Allowing this argument more weight than it perhaps deserves, it is easy to show that it cannot affect seriously our knowledge of the length of the mean free path.

Prof. George Darwin (*Phil. Trans.*, 180) has handled the problem of a mixture of unequal spherical bodies in the particular case in which the sizes are distributed according to the law of errors, which would involve far greater inequalities than can occur among atoms. Without discussing the precise details of his problem, it is sufficient to say that in the case considered by him the length of the mean free path is 7/11 of what it would be if the particles were equal. Hence, were the inequalities of atoms as great as in this extreme case, the reduction of the mean free path in hydrogen could only be from 185 to 119 $\mu\mu$; but they must be far less, and therefore the error, if any, due to this cause could not approach this amount. It is probably inappreciable.

Such examples might be multiplied, but the one I have selected is perhaps sufficient to illustrate my point, viz., that considerable and fairly accurate knowledge can be obtained as to molecular quantities by the aid of theories the details of which are provisional, and are admittedly capable of improvement.

Is the Model Unique?

But the argument that a correct result may sometimes be obtained by reasoning on imperfect hypotheses raises the question as to whether another danger may not be imminent. To be satisfactory, our model of Nature must be unique, and it must be impossible to imagine any other which agrees equally well with the facts of experiment. If a large number of hypotheses could be framed with equal claims to validity, that fact would alone raise grave doubts as to whether it were possible to distinguish between the true and the false. Thus Prof. Poincaré has shown that an infinite number of dynamical explanations can be found for any phenomenon which satisfies certain conditions. But though this consideration warns us against the too ready acceptance of explanations of isolated phenomena, it has no weight against a theory which embraces so vast a number of facts as those included by the atomic theory. It does not follow that, because a number of solutions are all formally dynamical, they are therefore all equally admissible. The pressure of a gas may be explained as the result of a shower of blows delivered by molecules, or by a repulsion between the various parts of a continuous medium. Both solutions are expressed in dynamical language; but one is, and the other is not, compatible with the observed phenomena of expansion. The atomic theory must hold the field until another can be found which is not inferior as an explanation of the fundamental difficulties as to the constitution of matter, and is, at the same time, not less comprehensive.

On the whole, then, the question as to whether we are attempting to solve a problem which has an infinite number of solutions may be put aside until one solution has been found which is satisfactory in all its details. We are in a sufficient difficulty about that to make the rivalry of a second of the same type very improbable.

The Phenomena of Life.

But it may be asked—nay, it has been asked—may not the type of our theories be radically changed? If this question does not merely imply a certain distrust in our own powers of reasoning, it should be supported by some indication of the kind of change which is conceivable.

Perhaps the chief objection which can be brought against physical theories is that they deal only with the inanimate side of Nature, and largely ignore the phenomena of life. It is therefore in this direction, if in any, that a change of type may be expected. I do not propose to enter at length upon so difficult a question, but, however we may explain or explain away the characteristics of life, the argument for the truth of the atomic theory would only be affected if it could be shown that living matter does not possess the thermal and mechanical properties, to explain which the atomic theory has been framed. This is so notoriously not the case that there is the gravest doubt whether life can in any way interfere with the action within the organism of the laws of matter in bulk belonging to the domain of mechanics, physics, and chemistry.

Probably the most cautious opinion that could now be expressed on this question is that, in spite of some outstanding difficulties which have recently given rise to what is called Neo-vitalism, there is no conclusive evidence that living matter can suspend or modify any of the natural laws which would affect it if it were to cease to live. It is possible that though subject to these laws the organism while living may be able to employ, or even to direct, their action within itself for its own benefit, just as it unquestionably does make use of the processes of external nature for its own purposes; but if this be so, the seat of the controlling influence is so withdrawn from view that, on the one hand, its very existence may be denied, while, on the other hand, Prof. Haeckel, following Vogt, has recently asserted that "matter and ether are not dead, and only moved by extrinsic force; but they are endowed with sensation and will; they experience an inclination for condensation, a dislike for strain; they strive after the one and struggle against the other" ("Riddle of the Universe," English translation, 1900, p. 380).

But neither unproved assertions of this kind nor the more refined attempts that have been made by others to bring the phenomena of life and of dead matter under a common formula touch the evidence for the atomic theory. The question as to whether matter consists of elements capable of independent motion is prior to and independent of the further questions as to what these elements are, and whether they are alive or dead.

The physicist, if he keeps to his business, asserts, as the bases of the atomic theory, nothing more than that he who declines to admit that matter consists of separate moving parts must regard many of the simplest phenomena as irreconcilable and unintelligible, in spite of the fact that means of reconciling them are known to everybody, in spite of the fact that the reconciling theory gives a general correlation of an enormous number of phenomena in every branch of science, and that the outstanding difficulties are connected, not so much with the fundamental hypotheses that matter is composed of distinguishable entities which are capable of separate motions as with the much more difficult problem of what these entities are.

On these grounds the physicist may believe that, though he cannot handle or see them, the atoms and molecules are as real as the ice crystals in a cirrus cloud which he cannot reach; as real as the unseen members of a meteoric swarm whose death-glow is lost in the sunshine, or which sweep past us, unentangled, in the night.

If the confidence that his methods are weapons with which he can fight his way to the truth were taken from the scientific explorer, the paralysis which overcomes those who believe that they are engaged in a hopeless task would fall upon him.

Physiology has specially flourished since physiologists have believed that it is possible to master the physics and chemistry of the framework of living things, and since they have abandoned the attitude of those who placed in the foreground the doctrine of the vital force. To supporters of that doctrine the principle of life was not a hidden directing power which could perhaps whisper an order that the flood-gates of reservoirs of energy should now be opened and now closed, and could, at the most, work only under immutable conditions to which the living and the dead must alike submit. On the contrary, their vital force pervaded the organism in all its parts. It was an active and energetic opponent of the laws of physics and chemistry. It maintained its own existence not by obeying but by defying them; and though destined to be finally overcome in the separate campaigns of which each individual living creature is the scene, yet like some guerilla chieftain it was defeated here only to reappear there with unabated confidence and apparently undiminished force.

This attitude of mind checked the advance of knowledge. Difficulty could be evaded by a verbal formula of explanation which in fact explained nothing. If the mechanical, or physical, or chemical causes of a phenomenon did not lie obviously upon the surface, the investigator was tempted to forego the toil of searching for them below; it was easier to say that the vital force was the cause of the discrepancy, and that it was hopeless to attempt to account for the action of a principle which was incomprehensible in its nature.

For the physicist the danger is no less serious, though it lies in a somewhat different direction. At present he is checked in his theories by the necessity of making them agree with a comparatively small number of fundamental hypotheses. If this check were removed, his fancy might run riot in the wildest speculations, which would be held to be legitimate if only they led to formulæ in harmony with facts. But the very habit of regarding the end as everything, and the means by which it was attained as unimportant, would prevent the discovery of those fragments of truth which can only be uncovered by the painful process of trying to make inconsistent theories agree, and using all facts, however remote, as the tests of our central generalisation.

"Science," said Helmholtz, "Science, whose very object it it is to comprehend Nature, must start with the assumption that Nature is comprehensible." And again, "The first principle of the investigator of Nature is to assume that Nature is intelligible to us, since otherwise it would be foolish to attempt the investigation at all." These axioms do not assume that all the secrets of the universe will ultimately be laid bare, but that a search for them is hopeless if we undertake the quest with the conviction that it will be in vain. As applied to life, they do not deny that in living matter something may be hidden which neither physics nor chemistry can explain, but they assert that theaction of physical and chemical forces in living bodies can never be understood, if at every difficulty and at every check in our investigations we desist from further attempts in the belief that the laws of physics and chemistry have been interfered with by an incomprehensible vital force. As applied to physics and chemistry, they do not mean that all the phenomena of life and death will ultimately be included in some simple and self-sufficing mechanical theory: they do mean that we are not to sit down contented with paradoxes such as that the same thing can fill both a large space and a little one; that matter can act where it is not, and the like, if by some reasonable hypothesis, capable of being tested by experiment, we can avoid the acceptance of these absurdities. Something will have been gained if the more obvious difficulties are removed, even if we have to admit that in the background there is much that we cannot grasp.

The Limits of Physical Theories.

And this brings me to my last point. It is a mistake to treat physical theories in general, and the atomic theory in particular, as though they were parts of a scheme which has failed if it leaves anything unexplained, which must be carried on indefinitely on exactly the same principles, whether the ultimate results are, or are not, repugnant to common-sense.

Physical theories begin at the surface with phenomena which directly affect our senses. When they are used in the attempt to penetrate deeper into the secrets of Nature, it is more than probable that they will meet with insuperable barriers, but this fact does not demonstrate that the fundamental assumptions are false, and the question as to whether any particular obstacle will be for ever insuperable can rarely be answered with certainty.

Those who belittle the ideas which have of late governed the advance of scientific theory too often assume that there is no alternative between the opposing assertions that atoms and the ether are mere figments of the scientific imagination, or that, on the other hand, a mechanical theory of the atoms and of the ether, which is now confessedly imperfect, would, if it could be perfected, give us a full and adequate representation of the underlying realities.

For my own part I believe that there is a *via media.*

A man peering into a darkened room, and describing what he thinks he sees, may be right as to the general outline of the objects he discerns, wrong as to their nature and their precise forms. In his description fact and fancy may be blended, and it may be difficult to say where the one ends and the other begins; but even the fancies will not be worthless if they are based on a fragment of truth, which will prevent the explorer from walking into a looking-glass or stumbling over the furniture. He who saw "men as trees walking" had at least a perception of the fundamental fact that something was in motion around him.

And so, at the beginning of the twentieth century, we are neither forced to abandon the claim to have penetrated below the surface of Nature, nor have we, with all our searching, torn the veil of mystery from the world around us.

The range of our speculations is limited both in space and time: in space, for we have no right to claim, as is sometimes done, a knowledge of the "infinite universe"; in time, for the cumulative effects of actions which might pass undetected in the short span of years of which we have knowledge, may, if continued long enough, modify our most profound generalisations. If some such theory as the vortex-atom theory were true, the faintest trace of viscosity in the primordial medium would ultimately destroy matter of every kind. It is thus a duty to state what we believe we know in the most cautious terms, but it is equally a duty not to yield to mere vague doubts as to whether we can know anything.

If no other conception of matter is possible than that it consists of distinct physical units—and no other conception has been formulated which does not blur what are otherwise clear and definite outlines—if it is certain, as it is, that vibrations travel through space which cannot be propagated by matter, the two foundations of physical theory are well and truly laid. It may be granted that we have not yet framed a consistent image either of the nature of the atoms or of the ether in which they exist; but I have tried to show that in spite of the tentative nature of some of our theories, in spite of many outstanding difficulties, the atomic theory unifies so many facts, simplifies so much that is complicated, that we have a right to insist—at all events till an equally intelligible rival hypothesis is produced—that the main structure of our theory is true; that atoms are not merely helps to puzzled mathematicians, but physical realities.

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY MAJOR P. A. MACMAHON, D.Sc., F.R.S., PRESIDENT OF THE SECTION.

DURING the seventy meetings of the Association a pure mathematician has been president of Section A on ten or a dozen occasions. A theme taken by many has been a defence of the study of pure mathematics. I take Cayley's view expressed before the whole Association at Southport in 1883, that no defence is necessary, but were it otherwise, I feel that nothing need be added to the eloquent words of Sylvester in 1869 and of Forsyth in 1897. I intend, therefore, to make some remarks on several matters which may be interesting to the Section even at the risk of being considered unduly desultory.

Before commencing I must remark that during the twelve months that have elapsed since the Bradford Meeting we have lost several great men whose lives were devoted to the subjects of this Section. Hermite, the veteran mathematician of France, has left behind him a splendid record of purely scientific work. His name will be always connected with the herculean achievement of solving the general quintic equation by means of elliptic modular functions. Other work, if less striking, is equally of the highest order, and his treatise "Cours d'Analyse" is a model of style. Of Fitzgerald of Dublin it is not easy to speak in this room without emotion. For many years he was the life and soul of this Section. His enthusiasm in regard to all branches of molecular physics, the force and profundity of his speech, the vigour of his advocacy of particular theories, the acute thinking which enabled him to formulate desiderata, his warm interest in the work of others, and the unselfish aid he was so willing to give, are fresh in our remembrance. Rowland was in the forefront of the ranks of physicists. His death at a comparatively early age terminates the important series of discoveries which were proclaimed from his laboratory in the Johns Hopkins University at Baltimore. In Viriamu Jones we have lost an assiduous worker at physics whose valuable contributions to knowledge indicated his power to do much more for science. In Tait, Scotland possessed a powerful and original investigator. The extent and variety of his papers are alike remarkable, and in his collected works there exists an imperishable monument to his fame.

It is interesting, in this the first year of the new century, to take a rapid glance at the position that mathematicians of this country held amongst mathematicians a hundred years ago. During the greater part of the eighteenth century the study of mathematics in England, Scotland and Ireland had been at a very low ebb. Whereas in 1801 on the Continent there were the leaders Lagrange, Laplace and Legendre, and of rising men, Fourier, Ampère, Poisson and Gauss, we could only claim Thomas Young and Ivory as men who were doing notable work in research. Amongst schoolboys of various ages we note Fresnel, Bessel, Cauchy, Chasles, Lamé, Möbius, v. Staudt and Steiner on the Continent, and Babbage, Peacock, John Herschel, Henry Parr Hamilton and George Green in this country. It was not, indeed, till about 1845, or a little later, that we could point to the great names of William Rowan Hamilton, MacCullagh, Adams, Boole, Salmon, Stokes, Sylvester, Cayley, William Thomson, H. J. S. Smith and Clerk Maxwell as adequate representatives of mathematical science. It is worthy of note that this date, 1845, marks also the year of the dissolution of a very interesting society, the Mathematical Society of Spitalfields; and I would like to pause a moment, and, if I may say so, rescue it from the oblivion which seems to threaten it. In 1801 it was already a venerable institution, having been founded by Joseph Middleton, a writer of mathematical text-books, in 1717.[1] The members of the Society at the beginning were for the most part silk-weavers of French extraction; it was little more than a working man's club, at which questions of mathematics and natural philosophy were discussed every Saturday evening. The number of members was limited to the "square of seven," but later it was increased to the "square of eight," and later still to the "square of nine." In 1725 the place of meeting was changed from the Monmouth's Head to the White Horse in Wheeler Street, and in 1735 to the Ben Jonson's Head in Pelham Street. The subscription was six-and-sixpence a quarter, or sixpence a week, and entrance was gained by production of a metal ticket, which had the proposition of Pythagoras engraved on one side and a sighted quadrant with level on the other. The funds, largely augmented by an elaborate system of fines, were chiefly used for the purchase of books and philosophical apparatus. A president, treasurer, inspector of instruments, and secretary were appointed annually, and there were, besides, four stewards, six auditors and six trustees. By the constitution of the Society it was the duty of every member, if he were asked any mathematical or philosophical question by another member, to instruct him to the best of his ability. It was the custom for each member in rotation to lecture or perform experiments on each evening of meeting. There was a fine of half-a-crown for introducing controverted points of divinity or politics. The members dined together twice annually, viz. on the second Friday in January in London in commemoration of the birth of Sir Isaac Newton (this feast frequently took place at the Black Swan, Brown's Lane, Spitalfields), and on the second Friday in July "at a convenient distance in the country in commemoration of the birth of the founder." The second dinner frequently fell through because the members could not agree as to the locality. It was found necessary to introduce a rule fining members sixpence for letting off fireworks in the place of meeting. Every member present was entitled to a pint of beer at the common expense, and, further, every five members were entitled to call for a quart for consumption at the meeting. Such were some of the quaint regulations in force when about the year 1750 the Society moved to larger apartments in Crispin Street, where it remained without interruption till 1843. It appears from the old minute books that about the year 1750 the Society absorbed a small mathematical society which used to meet at the Black Swan, Brown's Lane, above mentioned, and that in 1783 an ancient historical society was also incorporated with it. By the year 1800 the class of the members had become improved, and we find some well-known names, such as Dolland, Simpson, Saunderson, Crossley, Paroissen and Gompertz. At the time lectures were given in all branches of science by the members in the Society's rooms, which on these occasions were open to the public on payment of one shilling. The arrangements for the session 1822–23 included lectures in mechanics, hydrostatics and hydraulics, pneumatics, optics, astronomy, chemistry, electricity, galvanism, magnetism and botany, illustrated by experiments. On account of these lectures the Society had to fight an action-at-law, and although the case was won, its slender resources were crippled for many years. In 1827 Benjamin Gompertz, F.R.S., succeeded to the presidency on the death of the Rev. George Paroissen. From the year 1830 onwards the membership gradually declined and the financial outlook became serious. In 1843 there was a crisis; the Society left Crispin Street for cheaper rooms at 9 Devonshire Street, Bishopsgate Street, and finally, in 1845, after a futile negotiation with the London Institution, it was taken over by the Royal Astronomical Society, which had been founded in 1821. The library and documents were accepted and the few surviving members were made life members of the Astronomical Society without payment. So perished this curious old institution; it had amassed a really valuable library containing books on all branches of science. The Astronomical Society has retained the greater part, but some have found their way to the libraries of the Chemical and other societies. An inspection of the documents establishes that it was mainly a society devoted to physics, chemistry and natural history. It had an extensive museum of curiosities and specimens of natural history, presented by individual members, which seems to have disappeared when the rooms in Crispin Street were vacated. It seems a pity that more effort was not made to keep the old institution alive. The fact is that at that date the Royal Society had no sympathy with special societies and did all in its power to discourage them. The Astronomical Society was only formed in 1821 in the teeth of the opposition of the Royal Society.

[1] Its first place of meeting was the Monmouth's Head, Monmouth Street, Spitalfields. This street has long disappeared. From a map of London of 1746 it appears to have run parallel to the present Brick Lane and to have orresponded to the present Wilks Street.

Reverting now to the date 1845, it may be said that from this period to 1866 much good work emanated from this country, but no Mathematical Society existed in London. At the latter date the present Society was formed, with De Morgan as its first president. Gompertz was an original member, and the only person who belonged to both the old and new societies. The thirty-three volumes of *Proceedings* that have appeared give a fair indication of the nature of the mathematical work that has issued from the pens of our countrymen. All will admit that it is the duty of any one engaged in a particular line of research to keep himself abreast of discoveries, inventions, methods and ideas, which are being brought forward in that line in his own and other countries. In pure science this is easier of accomplishment by the individual worker than in the case of applied science. In pure mathematics the stately edifice of the Theory of Functions has, during the latter part of the century which has expired, been slowly rising from its foundations on the continent of Europe. It had reached a considerable height and presented an imposing appearance before it attracted more than superficial notice in this country and in America. It is satisfactory to note that during recent years much of the leeway has been made up. English-speaking mathematicians have introduced the first notions into elementary text-books; they have written advanced treatises on the whole subject; they have encouraged the younger men to attend courses of lectures in foreign universities; so that to-day the best students in our universities can attend courses at home given by competent persons, and have the opportunity of acquiring adequate knowledge, and of themselves contributing to the general advance. The Theory of Functions, being concerned with the functions that satisfy differential equations, has attracted particularly the attention of those whose bent seemed to be towards applied mathematics and mathematical physics, and there is no doubt, in analogy with the work of Poincaré in celestial dynamics, those sciences will ultimately derive great benefit from the new study. If, on the other hand, one were asked to specify a department of pure mathematics which has been treated somewhat coldly in this country during the last quarter of the last century, one could point to geometry in general, and to pure geometry, descriptive geometry and the theory of surfaces in particular. This may doubtless be explained by the circumstance that, at the present time, the theory of differential equations and the problems that present themselves in their discussion are of such commanding importance from the point of view of the general advance of mathematical science that those subjects naturally prove to be most attractive.

As regards organisation and cooperation in mathematics, Germany, I believe, stands first. The custom of offering prizes for the solutions of definite problems which are necessary to the general advance obtains more in Germany and in France than here, where, I believe, the Adams Prize stands alone. The idea has an indirect value in pointing out some of the more pressing desiderata to young and enthusiastic students, and a direct importance in frequently, as it proves, producing remarkable dissertations on the proposed questions. The field is so vast that any comprehensive scheme of cooperation is scarcely possible, though much more might be done with advantage.

If we turn our eyes to the world of astronomy we find there a grand scheme of cooperation which other departments may indeed envy. The gravitation formula has been recognised from the time of Newton as ruling the dynamics of the heavens, and the exact agreement of the facts derived from observation with the simple theory has established astronomy as the most exact of all the departments of applied science. Men who devote themselves to science are actuated either by a pure love of truth or because they desire to apply natural knowledge to the benefit of mankind. Astronomers belong, as a rule, to the first category, which, it must be admitted, is the more purely scientific. We not only find international cooperation in systematically mapping the universe of stars and keeping all portions of the universe under constant observation, but also when a particular object in the heavens presents itself under circumstances of peculiar interest or importance, the observatories of the world combine to ascertain the facts in a manner which is truly remarkable. As an illustration, I will instance the tiny planet Eros discovered a few years ago by De Witt. Recently the planet was in opposition and more favourably situated for observation than it will be again for thirty years. It was determined, at a conference held in Paris in July 1900, that combined work should be undertaken by no fewer than fifty observatories in all parts of the world. Beyond the fixing of the elements of the mean motion and of the perturbations of orbit due to the major planets, the principal object in view is the more accurate determination of solar parallax. To my mind this concert of the world, this cosmopolitan association of fine intellects, fine instruments, and the best known methods, is a deeply impressive spectacle and a grand example of an ideal scientific spirit. Other sciences are not so favourably circumstanced as is astronomy for work of a similar kind undertaken in a similar spirit. If in comparison they appear to be in a chaotic state, the reason in part must be sought for in conditions inherent to their study, which make combined work more difficult, and the results of such combined work as there is less striking to spectators. Still, the illustration I have given is a useful object-lesson to all men of science, and may encourage those who have the ability and the opportunity to make strenuous efforts to further progress by bringing the work of many to a single focus.

In pure science we look for a free interchange of ideas, but in applied physics the case is otherwise, owing to the fact that the commercial spirit largely enters into them. In a recent address, Prof. Perry has stated that the standard of knowledge in electrical engineering in this country is not as high as it is elsewhere, and all men of science and many men in the street know that he is right. This is a serious state of affairs, to which the members of this Section cannot be in any sense indifferent. We cannot urge that it is a matter with which another Section of the Association is concerned to a larger degree. It is our duty to take an active, and not merely passive attitude towards this serious blot on the page of applied science in England. For this many reasons might be given, but it is sufficient to instance one, and to state that neglect of electrical engineering has a baneful effect upon research in pure science in this country. It hinders investigations in pure physics by veiling from observation new phenomena which arise naturally, and by putting out of our reach means of experimenting with new combinations on a large scale. Prof. Perry has assigned several reasons for the present *impasse*, viz., a want of knowledge of mathematics on the part of the rising generation of engineers; the bad teaching of mathematics, and antiquated methods of education generally; want of recognition of the fact that engineering is not on stereotyped lines, but, in its electrical aspect, is advancing at a prodigious rate; municipal procrastination, and so on. He confesses, moreover, that he does not see his way out of the difficulty, and is evidently in a condition of gloomy apprehension.

It is, I think, undoubted that science has been neglected in this country, and that we are reaping as we have sowed. The importance of science teaching in secondary schools has been overlooked. Those concerned in our industries have not seen the advantage of treating their workshops and manufactories as laboratories of research. The Government has given too meagre an endowment to scientific institutions, and has failed to adequately encourage scientific men and to attract a satisfactory quota of the best intellects of the country to the study of science. Moreover, private benefactors have not been as numerous as in some other countries in respect of those departments of scientific work which are either non-utilitarian or not immediately or obviously so. We have been lacking alike in science organisation and in effective cooperation in work.

It has been attempted to overcome defects in training for scientific pursuits by the construction of royal roads to scientific knowledge. Engineering students have been urged to forego the study of Euclid, and, as a substitute, to practise drawing triangles and squares; it has been pointed out to them that mathematical study has but one object, viz., the practical carrying out of mathematical operations; that a collection of mathematical rules of thumb is what they should aim at; that a knowledge of the meaning of processes may be left out of account so long as a sufficient grasp of the application of the resulting rules is acquired. In particular, it has been stated that the study of the fundamental principles of the infinitesimal calculus may be profitably deferred indefinitely so long as the student is able to differentiate and integrate a few of the simplest functions that are met with in pure and applied physics. The advocates of these views are, to my mind, urging a process of "cramming" for the work of life which compares unfavourably with that adopted by the so-called "crammers" for examinations; the latter I believe to be, as a rule, much maligned individuals, who succeed by good organisation, hard work and personal influence, where the majority of public and private schools fail; the examinations for which their students compete encourage them to teach their pupils to think, and not to rely principally upon remembering rules. The best objects of education, I believe, are the habits of thought and observation, the teaching of how to think, and the cultivation of the memory; and examiners of experience are able to a considerable extent to influence the teaching in these respects; they show the teachers the direction in which they should look for success. The result has been that the "crammer" for examinations, if he ever existed, has disappeared. But what can be said for the principle of cramming for the work of one's life? Here an examination would be no check, for examiners imbued with the same notion would be a necessary part of the system; the awakening of the student would come, perhaps slowly, but none the less inevitably; he might exist for a while on his formulæ and his methods, but with the march of events, resulting in new ideas, new apparatus, new designs, new inventions, new materials requiring the utmost development of the powers of the mind, he will certainly find himself hopelessly at sea and in constant danger of discovering that he is not alone in thinking himself an impostor. And an impostor he will be if he does not by his own assiduity cancel the pernicious effects of the system upon which he has been educated. I do not, I repeat, believe in royal roads, though I appreciate the advantage of easy coaches in kindred sciences. In the science to which a man expects to devote his life, the progress of which he hopes to further, and in which he looks for his life's success, there is no royal road. The neglect of science is not to be remedied by any method so repugnant to the scientific spirit; we must take the greater, knowing that it includes the less, not the less, hoping that in some happy-go-lucky way the greater will follow.

At the beginning of the nineteenth century it was possible for most workers to be well acquainted with nearly all important theories in any division of science; the number of workers was not great, and the results of their labours were for the most part concentrated in treatises and in a few publications especially devoted to science; it was comparatively easy to follow what was being done. At the present time the state of affairs is different. The number of workers is very large; the treatises and periodical scientific journals are very numerous; the ramifications of investigation are so complicated that it is scarcely possible to acquire a competent knowledge of the progress that is being made in more than a few of the subdivisions of any division of science. Hence the so-called specialist has come into being.

Evident though it be that this is necessarily an age of specialists, it is curious to note that the word "specialist" is often used as a term of opprobrium, or as a symbol of narrow-mindedness. It has been stated that most specialists run after scientific truth in intellectual blinkers; that they wilfully restrain themselves from observing the work of others who may be even in the immediate neighbourhood; that even when the line of pursuit intersects obviously other lines, such intersection is passed by without remark; that no attention is paid to the existence or the construction of connecting lines; that the necessity for collaboration is overlooked; that the general advance of the body of scientific truth is treated as of no concern; that absolute independence of aim is the thing most to be desired. I propose to inquire into the possibility of such an individual existing as a scientific man.

I take as a provisional definition of a specialist in science one who devotes a very large proportion of his energies to original research in a particular subdivision of his subject. It will be sufficient to consider the subjects that come under the purview of Section A, though it will be obvious that a similar train of reasoning would have equal validity in connection with the subjects included in any of the other sections. I take the word "specialist" to denote a man who makes original discoveries in some branch of science, and I deny that any other man has the right, in the modern meaning of the word, to be called by others, or to call himself, a specialist. I would not wish to be understood to imply a belief that a truly scientific man is necessarily a specialist; I do believe that a scientific man of high type is almost invariably an original discoverer in one or more special branches of science; but I can conceive that a man may study the mutual relations of different sciences and of different branches of the same science and may throw such an amount of light upon the underlying principles as to be in the highest degree scientific. I will now advance the proposition that, with this exception, all scientific workers are specialists; it is merely a question of degree. An extreme specialist is that man who makes discoveries in only one branch, perhaps a very narrow branch, of his subject. I shall consider that in defending him I am *a fortiori* defending the man who is a specialist, but not of this extreme character.

A subject of study may acquire the reputation of being narrow either because it has for some reason or other not attracted workers and is in reality virgin soil only awaiting the arrival of a husbandman with the necessary skill, or because it is an extremely difficult subject which has resisted previous attempts to elucidate it. In the latter case, it is not likely that a scientific man will obstinately persist in trying to force an entrance through a bare blank wall. Either from weariness in striving or from the exercise of his judgment he will turn to some other subdivision which appears to give greater promise of success. When the subject is narrow merely because it has been overlooked, the specialist has a grand opportunity for widening it and freeing it from the reproach of being narrow; when it is narrow from its inherent difficulty he has the opportunity of exerting his full strength to pierce the barriers which close the way to discoveries. In either case the specialist, before he can determine the particular subject which is to engage his thoughts, must have a fairly wide knowledge of the whole of his subject. If he does not possess this he will most likely make a bad choice of particular subjects, or, having made a wise selection, he will lack an essential part of the mental equipment necessary for a successful investigation. Again, though the subject may be a narrow one, it by no means follows that the appropriate or possible methods of research are prescribed within narrow limits. I will instance the Theory of Numbers, which, in comparatively recent times, was a subject of small extent and of restricted application to other branches of science. The problems that presented themselves naturally, or were brought into prominence by the imaginations of great intellects, were fraught with difficulty. There seemed to be an absence, partial or complete, of the law and order that investigators had been accustomed to find in the wide realm of continuous quantity. The country to be explored was found to be full of pitfalls for the unwary. Many a lesson concerning the danger of hasty generalisation had to be learnt and taken to heart. Many a false step had to be retraced. Many a road which a first reconnaissance had shown to be straight for a short distance was found, on further exploration, to change suddenly its direction and to break up into a number of paths which wandered in a fitful manner in country of increasing natural difficulty. There were few vanishing points in the perspective. Few, also, and insignificant were the peaks from which a general notion could be gathered of any considerable portion of the country. The surveying instruments were inadequate to cope with the physical characters of the land. The province of the Theory of Numbers was forbidding. Many a man returned empty-handed and baffled from the pursuit, or else was drawn into the vortex of a kind of maelström and had his heart crushed out of him. But early in the last century the dawn of a brighter day was breaking. A combination of great intellects—Legendre, Gauss, Eisenstein, Stephen Smith, &c.—succeeded in adapting some of the existing instruments of research in continuous quantity to effective use in discontinuous quantity. These adaptations are of so difficult and ingenious a nature that they are to-day, at the commencement of a new century, the wonder and, I may add, the delight of beholders. True it is that the beholders are few. To attain to the point of vantage is an arduous task demanding alike devotion and courage. I am reminded, to take a geographical analogy, of the Hamilton Falls, near Hamilton Inlet, in Labrador. I have been informed that to obtain a view of this wonderful natural feature demands so much time and intrepidity, and necessitates so many collateral arrangements, that a few years ago only nine white men had feasted their eyes on falls which are finer than those of Niagara. The labours of the mathematicians named have resulted in the formation of a large body of doctrine in the Theory of Numbers. Much that, to the superficial observer, appears to lie on the threshold of the subject is found to be deeply set in it and to be only capable of attack after problems at first sight much more complicated have been solved. The mirage that distorted the scenery and obscured the perspective has been to some extent dissipated; certain vanishing points have been ascertained; certain elevated spots giving extensive views have been either found or constructed. The point I wish to urge is that these specialists in the Theory of Numbers were successful for the reason that they were not specialists at all in any narrow meaning of the word. Success was only possible because of the wide learning of the investigator; because of his accurate knowledge of the instruments that had been made effective in other branches; because he had grasped the underlying principles which caused those instruments to be effective in particular cases. I am confident that many a worker who has been the mark of sneer and of sarcasm from the supposed extremely special character of his researches would be found to have devoted the larger portion of his time to the study of methods which had been available in other branches, perhaps remote from the one which was particularly attracting his attention. He would be found to have realised that analogy is often the finger-post that points the way to useful advance; that his mind had been trained and his work assisted by studying exhaustively the successes and failures of his fellow-workers. But it is not only existing methods that may be available in a special research.

Furthermore, a special study frequently creates new methods which may be subsequently found applicable in other branches. The Theory of Numbers furnishes several beautiful illustrations of this. Generally, the method is more important than the immediate result. Though the result is the offspring of the method, the method is the offspring of the search after the result. The Law of Quadratic Reciprocity, a cornerstone of the edifice, stands out not only for the influence it has exerted in many branches, but also for the number of new methods to which it has given birth, which are now a portion of the stock-in-trade of a mathematician. Euler, Legendre, Gauss, Eisenstein, Jacobi, Kronecker, Poincaré and Klein are great names that will be for ever associated with it. Who can forget the work of H. J. S. Smith on homogeneous forms and on the five-square theorem, work which gave rise to processes that have proved invaluable over a wide field, and which supplied many connecting links between departments which were previously in more or less complete isolation?

In this connection I will further mention two branches with which I may claim to have a special acquaintance—the theory of invariants and the combinatorial analysis. The theory of invariants was evolved by the combined efforts of Boole, Cayley, Sylvester and Salmon, and has progressed during the last sixty years with the cooperation, amongst others, of Aronhold, Clebsch, Gordan, Brioschi, Lie, Klein, Poincaré, Forsyth, Hilbert, Elliott and Young. It involves a principle which is of wide significance in all the subject-matters of inorganic science, of organic science, and of mental, moral and political philosophy. In any subject of inquiry there are certain entities, the mutual relations of which under various conditions it is desirable to ascertain. A certain combination of these entities may be found to have an unalterable value when the entities are submitted to certain processes or are made the subjects of certain operations. The theory of invariants in its widest scientific meaning determines these combinations, elucidates their properties, and expresses results when possible in terms of them. Many of the general principles of political science and economics can be expressed by means of invariantive relations connecting the factors which enter as entities into the special problems. The great principle of chemical science which asserts that when elementary or compound bodies combine with one another the total weight of the materials is unchanged, is another case in point. Again, in physics, a given mass of gas under the operation of varying pressure and temperature has the well-known invariant, pressure multiplied by volume and divided by absolute temperature. Examples might be multiplied. In mathematics the entities under examination may be arithmetical, algebraical, or geometrical; the processes to which they are subjected may be any of those which are met with in mathematical work. It is the *principle* which is so valuable. It is the *idea* of invariance that pervades to-day all branches of mathematics. It is found that in investigations the invariantive fractions are those which persist in presenting themselves, even when the processes involved are not such as to ensure the invariance of those functions. Guided by analogy may we not anticipate similar phenomena in other fields of work?

The combinatorial analysis may be described as occupying an extensive region between the algebras of discontinuous and continuous quantity. It is to a certain extent a science of enumeration, of measurement by means of integers as opposed to measurement of quantities which vary by infinitesimal increments. It is also concerned with arrangements in which difference of quality and relative position in one, two, or three dimensions are factors. Its chief problem is the formation of connecting roads between the sciences of discontinuous and continuous quantity. To enable, on the one hand, the treatment of quantities which vary *per saltum*, either in magnitude or position, by the methods of the science of continuously varying quantity and position, and on the other hand to reduce problems of continuity to the resources available for the management of discontinuity. These two roads of research should be regarded as penetrating deeply into the domains which they connect.

In the early days of the revival of mathematical learning in Europe the subject of "combinations" cannot be said to have rested upon a scientific basis. It was brought forward in the shape of a number of isolated questions of arrangement, which were solved by mere counting. Their solutions did not further the general progress, but were merely valuable in connection with the special problems. Life and form, however, were infused when it was recognised by De Moivre, Bernoulli and others that it was possible to create a science of probability on the basis of enumeration and arrangement. Jacob Bernoulli, in his "Ars Conjectandi," 1713, established the fundamental principles of the Calculus of Probabilities. A systematic advance in certain questions which depend upon the partitions of numbers was only possible when Euler showed that the identity $x^a x^b = x^{a+b}$ reduced arithmetical addition to algebraical multiplication and *vice versâ*. Starting with this notion, Euler developed a theory of generating functions on the expansion of which depended the formal solutions of many problems. The subsequent work of Cayley and Sylvester rested on the same idea, and gave rise to many improvements. The combinations under enumeration had all to do with what may be termed arrangements on a line subject to certain laws. The results were important algebraically, as throwing light on the theory of Algebraic series, but another large class of problems remained untouched, and was considered as being both outside of the scope and beyond the power of the method. I propose to give some account of these problems, and to give a short history of the way in which a method of solution has been reached. It will be gathered from remarks made above that I regard any department of scientific work which seems to be narrow or isolated as a proper subject for research. I do not believe in any branch of science or subject of scientific work being destitute of connection with other branches. If it appears to be so, it is especially marked out for investigation by the very unity of science. There is no necessarily pathless desert separating different regions. Now a department of pure mathematics which appeared to be somewhat in this forlorn condition a few years ago was that which included problems of the nature of the magic square of the ancients. Conceive a rectangular lattice or generalised chess board (*cf.* "Gitter," Klein), whose compartments are situations for given numbers or quantities, so that there is a rectangular array of certain entities. The general problem is the enumeration of the arrays when both the rows and the columns of the lattice satisfy certain conditions. With the simplest of such problems certain progress had undoubtedly been made. The article on Magic Squares in the "Encyclopædia Britannica" and others on the same subject in various scientific publications are examples of such progress, but the position of isolation was not sensibly ameliorated. Again, the well-known "problème des rencontres" is an instance in point. Here the problem is to place a number of different entities in an assigned order in a line and beneath them the same entities in a different order subject to the condition that the entities in the same vertical line are to be different. This easy question has been solved by generating functions, finite differences, and in many other ways. In fact, when the number of rows is restricted to two the difficulties inherent in the problem when more than two rows are in question do not present themselves. The problem of the Latin Square is concerned with a square of order n and n different quantities which have to be placed one in each of the n^2 compartments in such wise that each row and each column contains each of the quantities. The enumeration of such arrangements was studied by mathematicians from Euler to Cayley without any real progress being made. In reply to the remark "Cui bono?" I should say that such arrangements have presented themselves for investigation in other branches of mathematics. Symbolical algebras and in particular the theory of discontinuous groups of operations have their laws defined by what Cayley has termed a multiplication table. Such multiplication tables are necessarily Latin Squares, though it is not conversely true that every Latin Square corresponds to a multiplication table. One of the most important questions awaiting solution in connection with the theory of finite discontinuous groups is the enumeration of the types of groups of given order or of Latin Squares which satisfy additional conditions. It thus comes about that the subject of Latin Squares is important in mathematics, and some new method of dealing with them seemed imperative.

A fundamental idea was that it might be possible to find some mathematical operation of which a particular Latin Square might be the diagrammatic representative. If, then, a one-to-one correspondence could be established between such mathematical operations and the Latin Squares, the enumeration might conceivably follow. Bearing this notion in mind, consider the differentiation of x^n with regard to x. Noticing that the result is nx^{n-1} (n an integer), let us inquire whether we can break up the operation of differentiation into n elementary portions, each of which will contribute a unit to the resulting coefficient n. If we write down x^n as the product of n letters, viz. $xxxx$ . . ., it is obvious that if we substitute unity in place of a single x in all possible ways, and add together the results, we shall obtain nx^{n-1}. We have, therefore, n different elementary operations, each of which consists in substituting unity for x. We may denote these diagrammatically by

and from this point of view $\frac{d}{dx}$ is a combinatorial symbol, and denotes by the coefficient n the number of ways of selecting one out of n different things.

Similarly, the higher differentiations give rise to diagrams of two or more rows, the numbers of which are given by the coefficients which result from such differentiations. Following up this clue much progress has been made. For a particular problem success depends upon the design, on the one hand, of a function, on the other hand, of an operation such that diagrams make their appearance which have a one-to-one correspondence with the entities whose enumeration is sought. For a general investigation, however, it is more scientific to start by designing functions and operations, and to then ascertain the problems of which the solution is furnished. The difficulties connected with the Latin Square and with other more general questions have in this way been completely overcome.

The second new method in analysis that I desire to bring before the Section had its origin in the theory of partition. Diophantus was accustomed to consider algebraical questions in which the symbols of quantity were subject to certain conditions, such, for instance, that they must denote positive numbers or integer numbers. A usual condition with him was that the quantities must denote positive integers. All such problems, and particularly those last specified, are qualified by the adjective Diophantine. The partition of numbers is then on all fours with the Diophantine equation

$$\alpha+\beta+\gamma+ \dots +\nu=n,$$

a further condition being that one solution only is given by a group of numbers α, β, γ . . . satisfying the equation; that in fact permutations amongst the quantities α, β, γ . . . are not to be taken into account. This further condition is brought in analytically by adding the Diophantine inequalities

$$\alpha \geqq \beta \geqq \gamma \geqq . . . \geqq \nu \geqq 0$$

ν in number. The importation of this idea leads to valuable results in the theory of the subject which suggested it. A generating function can be formed which involves in its construction the Diophantine equation and inequalities, and leads after treatment to a representative as well as enumerative solution of the problem. It enables further the establishment of a group of fundamental parts of the partitions from which all possible partitions of numbers can be formed by addition with repetition. In the case of simple unrestricted partition it gives directly the composition by rows of units which is in fact carried out by the Ferrers-Sylvester graphical representation and has led in the hands of the latter to important results in connection with algebraical series which present themselves in elliptic functions and in other departments of mathematics. Other branches of analysis and geometry supply instances of the value of extreme specialisation.

What we require is not the disparagement of the specialist but the stamping out of narrow-mindedness and of ignorance of the nature of the scientific spirit and of the life-work of those who devote their lives to scientific research. The specialist who wishes to accomplish work of the highest excellence must be learned in the resources of science and have constantly in mind its grandeur and its unity.

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY PROF. J. COSSAR EWART, M.D., F.R.S., PRESIDENT OF THE SECTION.

The Experimental Study of Variation.

THE study of variation may be said to consist (1) in noting and classifying the differences between parents and their offspring; and (2) in determining by observation and experiment the causes of these differences, especially why only some of them are transmitted to future generations. The facts of variation having been dealt with at considerable length in a recent work by Mr. Bateson, I shall discuss chiefly the causes of variation.

Though for untold ages parents have doubtless observed differences in the form and temperament of their children, and though breeders have long noted unlooked-for traits in their flocks and herds, the systematic study of variation is of very recent date. This is not surprising, for while the belief in the immutability of species prevailed, there was no special incentive either to collect the facts or inquire into the causes of variation; and since the appearance in 1859 of the "Origin of Species" biologists have been mainly occupied in discussing the theory of natural selection. Now that discussions as to the nature and origin of species no longer occupy the chief attention of biologists, variability—the fountain and origin of progressive development—is likely to receive an ever-increasing amount of notice. Strange as it may appear, naturalists at the end of the eighteenth century concerned themselves more with the causes of variation than their successors at the end of the nineteenth. Buffon, who discussed at some length nearly all the great problems that interest naturalists to-day, after considering variation arrived at the conclusion that it was due to the direct action of the environment, and even invented a theory (strangely like Darwin's theory of pangenesis) to explain how somatic were converted into germinal variations. Erasmus Darwin and Lamarck also had views as to the causes of variation. Erasmus Darwin believed variability resulted from the efforts of the individual, new structures being gradually evolved by the organisms constantly endeavouring to adapt themselves to their surroundings. Lamarck about the same time endeavoured to prove that changes in the environment produced new needs, which in turn led to the formation of new organs and the modification of old ones, use being specially potent in perfecting the new, disuse in suppressing the old. Both Erasmus Darwin and Lamarck, without attempting, or apparently even seeing the need of, any such explanation as pangenesis offered, assumed that definite acquired modifications were transmitted to the offspring, and they both further assumed that variations occurred not in many but in a single definite direction; hence they had no need to postulate selection. The speculations of Erasmus Darwin and Lamarck having had little influence, it fell to Charles Darwin to construct new and more lasting foundations for the evolution theory.

Charles Darwin, clearly realising that variation occurs in many different directions, arrived at the far-reaching conclusion that the best adapted varieties are selected by the environment, and thus have a chance of giving rise to new species. Though impressed with the paramount importance of selection, Charles Darwin realised that "its action absolutely depends on what we in our ignorance call spontaneous or accidental variation."[1] Darwin, however, concerned himself to the last more with selection than with variation, doubtless because he believed variability sinks to a quite subordinate position when compared with natural selection. As variations stand in very much the same relation to selection as bricks and other formed material stand to the builder, Darwin was perhaps justified in rating so high the importance of the principle with which his name will ever be intimately associated. Though Darwin considered variability of secondary importance, it may be noted that he did more than any other naturalist to collect the facts of variation, and he moreover considered at some length the causes of variation. He regarded with most favour the view "that variations of all kinds and degrees are directly or indirectly caused by the conditions of life to which each being or more especially its ancestors have been exposed."[2] Of all the causes which induce variability, he believed excess of food was probably the most powerful.[3] In addition to variations which arise spontaneously in obedience to fixed and immutable laws, Darwin believed with Buffon that variations were produced by the direct action of the environment, and with Lamarck by the use and disuse of parts; and he accounted for the inheritance of such variations by his theory of pangenesis. Darwin seems always to have regarded the direct action of the environment and use and disuse as, at the most, subsidiary causes of variation; but Mr. Herbert Spencer and his followers regard "use-inheritance" as an all-important factor in evolution; while Cope and his followers in America, by a mixture of "use-inheritance" (Konetogenesis) and Lamarck's neck-stretching theory (Archæsthetism), apparently see their way to account for the evolution of animals with but little help from natural selection.

Prof. Weismann and others, however, have recently given strong reasons for the belief that all variation is the result of changes in the germ-plasm ultimately due to external stimuli, the environment acting directly on unicellular, indirectly on multicellular organism. It is convenient to speak of biologists who believe with Mr. Herbert Spencer in the law of use and disuse (use-inheritance) as Neo-Lamarckians, and of those who with Weismann refuse to accept the doctrine of the transmission of definite acquired characters, and in the case of multicellular organisms the direct influence of the environment as a cause of variation, as Neo-Darwinians. In discussing variability I shall assume that all variations are transmitted by the germ-cells; that the primary cause of variation is always the effect of external influences, such as food, temperature, moisture, &c.; and that "the origin of a variation is equally independent of selection and amphimixis" (Weismann, "The Germ-Plasm," p. 431), amphimixis being simply the means by which effect is given to differences inherited, and to the differences acquired by the germ-cells during their growth and maturation.

Theoretically the offspring should be an equal blend of the parents and (because of the tendency to reversion) of their respective ancestors. In as far as the offspring depart either in an old or in a new direction from this ideal intermediate condition they may be said to have undergone variation. The more obvious variations consist of a difference in form, size and colour, in the rate of growth, in the period at which maturity is reached, in the fertility, in the power to withstand disease and changes in the surroundings, of differences in temperament and instincts, and in the aptitude to learn. In the members of a human family there may be great dissimilarity, and the dissimilarity may be even greater in the members of a single brood or litter of domestic animals, especially if the parents belong to slightly different breeds.

[1] "Animals and Plants," vol. ii, p. 206.

[2] *Ibid.*, vol. ii, p. 240. Elsewhere he says we are "driven to the conclusion that in most cases the conditions of life play a subordinate part in causing any particular modification."

[3] *Ibid.*, vol. ii, p. 282.

Frequently some of the offspring closely resemble the immediate ancestors, while others suggest one or more of the remote ancestors, are nearly intermediate between the parents, or present quite new characters. Similarly seedlings from the same capsule often differ. Can we by way of accounting for these differences only with Darwin say variations are due to fixed and immutable laws, or at the most subscribe to the assertion of Weismann, that they are "due to the constant recurrence of slight inequalities of nutrition of the germ-plasm"? ("Germ-Plasm," p. 431). Weismann accounts for ordinary variation by saying that the reduction of the germ-plasm during the maturation of the germ-cell is qualitative as well as quantitative, *i.e.* that the germ-plasm retained in the ovum to form the female pro-nucleus is different from the germ-plasm discharged in the second polar body. He accounts for discontinuous variation and "sports" by "the permanent action of uniform changes in nutrition" ("Germ-Plasm," p. 431). These uniform changes in nutrition by modifying in a constant direction susceptible groups of germ-units (determinants) after a time giving rise to new, it may be pronounced variation. Must we rest satisfied with these assumptions, or is it possible to account for some of the variability met with by, say, differences in the maturity of the parents or of the germ-cells, by the germ-cells having been influenced by interbreeding or intercrossing, or by the soma in which they are lodged having been invigorated by a change of food, or habitat, or deteriorated by unfavourable surroundings or disease? In other words, are there valid reasons for believing that the germ-cells are extremely sensitive to changes in their immediate environment, *i.e.*, to modifications of the body, or soma containing them, and that the characters of the offspring depend to a considerable extent on whether the germ-cells have recently undergone rejuvenescence?

Obviously if the offspring, other things being equal, vary with the age of the parents, the ripeness of the germ-cells and with the bodily welfare, the qualitative division of the nucleus on which Weismann so much relies as an explanation of ordinary variation will prove inadequate.

Is Age a Cause of Variation?

During the course of my experiments on Variation I endeavoured to find an answer to the question, "Is Age a Cause of Variation?" During development and while nearly all the available nourishment is required for building up the organs and tissues of the body, the germ-cells remain in a state of quiescence. Sooner or later, however, they begin to mature, and eventually in most cases escape from the germ-glands. I find the first germ-cells ripened often prove infertile. When, *e.g.*, pigeons from the same nest are isolated and allowed to breed as soon as mature, they seldom hatch out birds from the first pair of eggs, and though quite vigorous in appearance they may only hatch a single bird from the second pair of eggs. The same result generally follows mating very young but quite unrelated pigeons; but when a young hen bird is mated with a vigorous, well-matured male, or a young male is mated with a vigorous, well-matured female, the eggs generally prove fertile from the first. The germ-cells are, as far as can be determined, structurally perfect from the outset; and that they only fail in vigour is practically proved by the fact that though the conjugation of germ-cells from two young birds leads to nothing, the conjugation of germ-cells from quite young birds with germ-cells from mature birds generally at once results in offspring.

The following experiments indicate how age may prove a cause of variation. Last autumn I received from Islay two young male blue-rock pigeons which, though bred in captivity, were believed to be as pure as the wild birds of the Islay caves. In February last one of the young blue-rocks, while still immature, was placed with an inbred white fantail, the other with an extremely vigorous well-matured black barb. In course of time a pure-white bird was reared by the white fantail, and two dark birds by the black barb. Owing probably to the fantail being inbred and the blue-rock being still barely mature, the young white bird died soon after leaving the nest. No birds were hatched from the second and third pairs of eggs laid by the fantail, but from the fourth pair two birds were hatched which are now nearly full-grown. These young birds are of a darker shade of blue, and look larger and more vigorous than their blue-rock sire. As in the Indian variety of the blue-rock pigeon the croup is blue, and, as in some of the Eastern blue-rocks, the wings are slightly chequered. They, however, only essentially differ from their sire in having four extra feathers in the tail. The first pair of birds hatched by the black barb when they reached maturity early in August might have passed for young barbs with somewhat long beaks. Since the first pair were hatched in March the blue-rock and black barb have reared six other birds. One of the second brood closely resembles the first birds hatched; the other is of a greyish colour, with slightly mottled wings, a long beak, and a tail bar. The birds of the third nest are both of a greyish colour, but have indistinct wing bars as well as a tail bar. Of the fourth pair of young, one is greyish like the birds of the third nest, the other is of a dark blue colour with slightly chequered wings, and a head, beak and bars as in its blue-rock sire. The gradual change from black to dark blue in the blue-rock barb crosses is very remarkable. I can only account for the almost mathematical regularity of the change by supposing it has kept pace with a gradual increase in the vigour or prepotency in the young blue-rock. Eventually the offspring of the blue-rock mated to the black barb, like the offspring of its brother with the white fantail, may be of a slaty blue colour, and otherwise resemble a wild blue-rock pigeon. Many breeders would explain the offspring taking more and more after the sire by the doctrine of Saturation—a doctrine that finds much favour amongst breeders—but as identical results were obtained when young females were mated with well-matured males the saturation explanation falls to the ground.

Like results were obtained by breeding young grey quarter-wild rabbits with an old white Angora buck: the first young were white, the subsequent young were white, grey and bluish grey. From these results it follows that when old and young but slightly different members of a variety or species are marked a wonderfully perfect series of intermediate forms is likely to be produced. Amongst wild animals the young males rarely have a chance of breeding with the young females; hence amongst wild animals, owing to age being a cause of variation, a considerable amount of material is doubtless constantly provided for selection, thus affording a variety an additional chance of adapting itself to slight fluctuations in the environment.

In the results obtained by crossing mature, vigorous, and, in some cases, inbred males with barely mature females, an explanation may be found why in some families the same features have persisted almost unaltered for many generations; why in his features the squire of to-day sometimes exactly reproduces the lines of his ancestors, as seen in portraits and monumental brasses. It should, however, be borne in mind that highly prepotent forms are capable from the first of so completely controlling the development that they transmit their peculiar traits to all their offspring.

Is Ripeness of the Germ-Cells a Cause of Variation?

While difference in age may sometimes account for the earlier broods and litters resembling one of the parents, it fails to account for the very pronounced variation often found in a single brood or litter, and for much of the dissimilarity between members of the same human family. When a *single* fertilised germ-cell, as occasionally happens, gives rise to twins, they are always identical; hence it may be assumed the differences in members of the same family have their source in differences in the germ-cells from which they spring. If the offspring vary with the maturity of the soma, it may also vary with the maturity of the germ-cells, or at least with their condition at the moment of conjugation.

Some years ago Mr. H. M. Vernon, when hybridising echinoderms, discovered that "the characteristics of the hybrid offspring depend directly on the relative degrees of maturity of the sexual products" (*Proceedings* Royal Society, vol. lxiii. May 1898). Mr. Vernon found subsequently that over-ripe (stale) ova fertilised with fresh sperms gave very different results from fresh ova fertilised with over-ripe (stale) sperms, from which he inferred that over-ripeness (staleness) is a very potent cause of variation (*ibid.*, vol. lxv. November 1899).

I find that if a well-matured rabbit doe is prematurely (*i.e.*, some time before ovulation is due) fertilised by a buck of a different strain, the young take after the sire; when the fertilisation takes place at the usual time, some of the young resemble the buck, some the doe, while some present new characters or reproduce more or less accurately one or more of the ancestors. When, however, the mating is delayed for about thirty hours beyond the normal time, all the young, as a rule, resemble the doe. It may hence be inferred that in mammals, as in echinoderms, the characters of the offspring are related to the condition of the germ-cells at the moment of conjugation, the offspring resulting from the union of equally ripe germ-cells differing from the offspring developed from the conjugation of ripe and unripe germ-cells, and still more from the union of fresh and over-ripe germ-cells. This conclusion may be said to be in harmony with the view expressed by Darwin, that the causes which induce variability probably act "on the sex elements before impregnation has been effected" ("Animals and Plants," vol. ii. p. 259). The results already obtained, though far from answering the question why there is often great dissimilarity between members of the same family, may lead to further experiment, and especially to more complete records being kept by breeders. It is unnecessary to point out what a gain it would be were breeders able to regulate, even to a small extent, the characters of the offspring.

Is the Condition of the Soma a Cause of Variation?

There is a considerable amount of evidence in support of the view that changes in any part of the body or soma which affect the general welfare influence the germ-cells. This is but what might be expected if the soma in the metazoa is to the germ-cells what the immediate surroundings are to the protozoa. The soma from the first forms a convenient nidus for the germ-cells, and when sufficiently old and sufficiently nourished it provides the stimuli by which the ripening (maturing) of the germ-cells is effected. If in the case of the protozoa variation is due to the direct action of the environment, it may be inferred that in the metazoa variations of the germ-cells result from the direct action of the soma, *i.e.*, from the direct action on the germ-cells of their immediate environment. This, however, is quite a different thing from saying that definite somatic variations are incorporated in the germ-cells (converted into germinal variations) and transmitted to the offspring.

It may first be asked, Does disease in as far as it reduces the general vigour or interferes with the nutrition of the germ-cells act as a cause of variation? I recently received a number of blue-rock pigeons from India infected with a blood parasite (Halteridium) not unlike the organism now so generally associated with malaria. In some pigeons the parasites were very few in number, in others they were extremely numerous. The eggs of a pair of these Indian birds with numerous parasites in the blood proved infertile. Eggs from a hen with numerous parasites fertilised by a cock with a few parasites proved fertile, but the young died before ready to leave the nest. An old male Indian bird, however, with comparatively few parasites mated with a mature half-bred English turbit produced a single bird. The half-bred turbit has reddish wings and shoulders, but is otherwise white. The young bird by the Indian blue-rock is of a reddish colour nearly all over, but in make not unlike the cross-bred turbit hen.

Some time before the second pair of eggs were laid the parasites had completely disappeared from the Indian bird, and he looked as if he had quite recovered from his long journey, as well as from the fever. In due time a pair of young were hatched from the second eggs, and as they approached maturity it became more and more evident that they would eventually present all the distinctive points of the wild-rock pigeon.[1] The striking difference between the first bird reared and the birds of the second nest might, however, be due not to the malaria parasites but to the change of habitat.

Against this view, however, is the fact that another Indian bird infected to about the same extent as the mate of the half-bred red turbit counted for little when mated with a second half-bred turbit; while two Indian birds in which extremely few parasites were found at once produced blue-rock-like birds when bred—one with a fantail, the other with a tumbler.

Another possible explanation of the difference between the bird of the first and the birds of the second nest is that the germ-cells were for a time infected by the minute protozoan Halteridium in very much the same way as the germ-cells of ticks are infected by the parasite of Texas fever. But of this there is no evidence, for even in the half-grown birds hatched by the pure-bred malarious Indian rocks the most careful examination failed to detect any parasites in the blood. In all probability Halteridium can only be conveyed from one pigeon to another by Culex or some other gnat.

These results with pigeons suffering from malaria seem to ndicate that the germ-cells are liable to be influenced by fevers and other forms of disease that for the time being diminish the vitality of the parents. Further experiments may show that the germ-cells are influenced in different ways by different diseases.

Sometimes the germ-cells suffer from the direct action of their immediate environment, from disturbance in or around the germ-glands. If, for example, inflammation by the ducts or other channels reaches the germ-glands, the vitality of the germ-cells may be considerably diminished; if serious or prolonged, the germ-cells may be as effectively sterilised as are the bacteria of milk by boiling.

In 1900 two mares produced foals to a bay Arab which had previously suffered from a somewhat serious illness involving the germ-glands. These foals in no way suggest their sire. This year I have three foals by the same Arab after he had quite recovered: one promises to be the image of his sire, and the other two are decidedly Arab-like both in make and action.

While the germ-cells are liable to suffer when the soma is the subject of disease, there is no evidence that they are capable of being so influenced that they transmit definite or particular modifications (unless directly infected with bacteria or other minute organisms); that, *e.g.*, the germ-cells of gouty subjects necessarily give rise to gouty offspring. Doubtless if the germ-cells, because of their unfavourable immediate surroundings, suffer in vigour or vitality, the offspring derived from them are likely to be less vigorous, and hence more likely than their immediate ancestors to suffer from gout and other diseases.

It would be an easy matter to give instances of the offspring varying with the condition or fitness of the parents; but it will suffice if, before discussing intercrossing, I refer to the influence of a change of habitat.

Is Change of Habitat a Cause of Variation?

It has long been recognised that a change of surroundings may profoundly influence the reproductive system, in some cases increasing the fertility, in others leading to complete sterility. Exotic plants, sterile it may be at first, often become extremely fertile, and when thoroughly established give rise to new varieties. In the case of mares obtained from Iceland and the south of England sometimes a year elapses before they breed. An Arab-Kattiawar pony which arrived during April from India proved during the first three months quite sterile, owing, I believe, to loss of vigour on the part of the germ-cells, their vitality being only about one-tenth that of a home-bred hackney pony. But the fertility is apparently greatly impaired by even comparatively slight changes of environment. Lions which breed freely in Dublin seem to be sterile in London, and I heard recently that when bulls are changed from one district to another in the north of Ireland complete sterility is sometimes the result. The tendency of some exotic plants to "sport" after they become acclimatised is doubtless due to the fact that their new habitat is unusually favourable, their general vigour—so essential for new developments—is increased, and, probably because certain groups of germ units are constantly stimulated by the new food available, they give rise abruptly or gradually to new and it may be unexpected characters. No one doubts that the bodily vigour is liable to be impaired by fevers and other diseases, by changes in the habitat, unsuitable food, rapid and unseasonable changes of temperature, and the like; hence it will not be surprising if further investigations prove that changes in the soma, beneficial as well as injurious, are reflected in the germ-cells, and thus indirectly induce variation. Moreover there are excellent reasons for believing that the germ-cells are influenced by seasonable changes, such as moulting in birds and changing the coat in mammals. In the case of pigeons, *e.g.*, the young bred in early summer are, other things being equal, larger and more vigorous, and mature more rapidly, than birds hatched in the late summer or autumn. But however sensitive the germ-cells may be to the changes of their immediate environment, *i.e.*, the soma or body in which they are lodged, there is no evidence whatever that (as Buffon asserted and Darwin thought possible) definite changes of the soma, due to the direct action of the environment, can be imprinted on the germ-cells. By the direct action of the environment—food, temperature, moisture, &c.—the body in whole or in part may be dwarfed, increased, or otherwise modified; but such changes only influence the germ-cells in as far as they lead to modifications of the body as a whole. They may expedite or delay maturity, after the length of the reproductive period, interfere with the nutrition of the germ-cells, or retard the development of the embryo, but they seem incapable of giving rise to definite structural or functional variations in the offspring.

[1] In these young birds the breast and some of the wing feathers are imperfect. Fanciers regard this condition of the feathers as evidence of contitutional weakness.

Intercrossing and Interbreeding as Causes of Variation.

The belief was once common amongst naturalists that variability was wholly due to crossing, and at the present day naturalists and breeders alike agree that intercrossing is a potent cause of variability, and are unanimous in regarding interbreeding as an equally potent means of checking variability. The opinion is also general that intercrossing has a swamping influence; that having brought forth new forms it forthwith proceeds to destroy them. Darwin, when discussing reversion, points out that intercrossing often speedily leads to almost complete reversion to a long-lost ancestor, *i.e.*, to the loss of recently acquired and the reappearance of long lost characters "Animals and Plants," vol. i. p. 22). When, however, he comes to deal with variability, he states that "crossing, like any other change in the conditions of life, seems to be an element, probably a potent one, in causing variability (*ibid.*, vol. ii. p. 254), the offspring of the first generation being generally uniform, but those subsequently produced displaying an almost infinite diversity of character. As to the influence of inbreeding he says, "close interbreeding, if not carried to an injurious extreme, far from causing variability, tends to fix the character of each breed (*ibid.*, vol. ii. p. 251).

These statements may be quoted in support of the very common belief that intercrossing is both a potent cause of variation and of reversion; that it produces new varieties one moment and swamps them the next. Whether intercrossing may be regarded as the immediate cause of variation or of reversion (it can hardly be both) depends on what is implied by variation. Obviously variation may be either progressive or retrogressive, *i.e.*, the offspring may differ from their parents in having quite new characters or in presenting ancestral characters, or in being characterised by traits neither new nor old, due to new combinations of characters already recognised as belonging to the variety or species. When intercrossing results in the restoration of old characters, we have reversion or retrogressive variation; when to new combinations of already existing characters like new combinations in a kaleidoscope, we have new variations of a non-progressive kind, almost always characterised by more or less reversion; when, however, intercrossing results in the characters of one variety being engrafted on another, or to the appearance of characters quite new to the species, we have progressive variation. Judging from the results I have obtained, intercrossing of two distinct varieties results, as a rule, in the loss of the more striking characters of both parents, *i.e.* in more or less marked reversion, the extent of the loss generally depending on the difference between the forms crossed. For example, if an owl pigeon is crossed with a pigeon known among fanciers as an archangel, nondescript birds are obtained, which may at once, with a white fantail, give birds almost identical with a blue-rock—the common ancestor of all our breeds of pigeons. Intercrossing, on the other hand, rarely leads to the blending in one individual of the unaltered characters of two or more varieties, and it never results in the appearance of characters absolutely new to the species. In a word, the immediate result of intercrossing distinct varieties is, as a rule, more or less marked reversion. But though intercrossing usually results in retrogressive variation, it is *indirectly* an extremely potent cause of progressive variation. This is due to the fact (better realised by botanists than zoologists) that cross-bred offspring (first crosses) are (unless the parents have been enfeebled by interbreeding) endowed with an unusual amount of vigour, *i.e.*, intercrossing is of supreme importance, not only because it leads to the co-mingling of germ-plasms having different tendencies, but also and perhaps chiefly because of its rejuvenating influence. The importance of this rejuvenation is usually at once evident if intercrossing is immediately followed by interbreeding. The interbreeding of closely related forms generally reduces the vigour, and, as Darwin points out, "far from causing variability, tends to fix the character of each breed" ("Animals and Plants," vol. ii. p. 251); but the intercrossing of first crosses (or of highly vigorous individuals closely related in either the direct or the collateral line) without appreciably weakening the constitution, often results in offspring displaying, to use Darwin's words, "an almost infinite diversity of character" (*ibid.*, vol. ii. p. 256). The epidemics of variation, so often the outcome of interbreeding first or at least vigorous recently produced crosses, are apparently partly due to the union of individuals having a similar tendency checking reversion, and partly to the vigour acquired by recent intercrossing. This much may be inferred from the fact, that when interbreeding is persisted in the variability dwindles as the vigour ebbs.

Breeders agree with Darwin that first crosses are generally uniform, and that the subsequent offspring usually vary immensely; yet neither breeders nor naturalists seem to have clearly realised that interbreeding at the right moment is the *direct* cause of variation, while intercrossing is, except in very rare cases, at the most an *indirect* cause of variation.

It may be here said that it is impossible to over-estimate the importance of vigour in studying variation. Without vigour no race or breed can maintain its position; without renewed vigour it is hardly likely to develop new characters. The new vigour, as already explained, may be obtained by intercrossing; but it may also be acquired, especially in plants, by a change of surroundings accompanied by a plentiful supply of suitable food.

With rigid selection the gradual loss of vigour may escape notice, but when selection is suspended rapid deterioration (from the fancier's standpoint) is the inevitable result. If, *e.g.*, a number of pigeons, good specimens of a distinct breed, are isolated and left unmolested for a few years, they rapidly degenerate, *i.e.*, they lose their show points (be they peaks, frills, ruffs, or metallic tints) and reassume the more fixed ancestral characters. If, however, the less characteristic birds are eliminated, and high-class birds are from time to time introduced from another loft, the vigour and the distinctive traits are indefinitely preserved.

If the age and condition of the soma and the state of ripeness of the germ-cells are potent factors, and especially if vigour counts for much, the difficulties of breeders become intelligible, and the unlikeliness of intercrossing being a direct cause of variation all the more evident. The most that can be expected from intercrossing is the engrafting on one breed the characters of another. Even this rarely happens, and is only possible when the two breeds are somewhat allied. It is impossible, *e.g.*, to unite in one individual all the points of a fantail and a pouter, or of a fantail and a jacobin; but given healthy, vigorous birds, the points of an owl may be engrafted on a barb. Or to take another example, the black ears, feet, &c., of a Himalaya rabbit may be combined with the characteristic form, long hair and habits of an Angora. It may be impossible to predict what will happen when intercrossing is resorted to, but if pure-bred members of a distinct variety are experimented with —and it is useless working with either plants or animals of unknown origin—characters not already present in one of the varieties need not be looked for.

But while interbreeding at the right moment may be a cause of progressive variation, at other times it leads to what is perhaps best described as degeneration. When, *e.g.*, very young members of the same brood or litter, or unhealthy, closely related individuals, or quite mature and apparently vigorous but for several generations closely related animals are interbred, the offspring frequently differ from their parents. They are often delicate and highly sensitive, and unable to survive unless provided with highly nutritious food; and though they mature numerous germ-cells they rear but few offspring, and, what is still more striking, they are sometimes either white or all but devoid of pigment. Offspring thus characterised, especially when white or nearly white in colour, *e.g.*, nearly white pheasants, partridges, and woodcock, white specimens of the brown hare, white squirrels, &c., are sometimes regarded as distinct varieties, but when the departure from the normal colour, &c., is the result of close inbreeding it is best regarded as degeneration.

In the spring of 1900 I crossed a quarter-wild grey doe rabbit with a closely inbred black-and-white buck. The young obtained varied considerably in colour: to one of her offspring coloured like the sire, the grey doe produced a second litter, all but one decidedly lighter in colour than the sire. Two of the darker members of this litter produced almost white young, and to one of them the original grey doe has recently produced a light-coloured litter consisting of two pure white specimens, two with only a narrow dorsal band, two fawn-coloured and one black. Close interbreeding with goats and pigeons yields similar results. Birds on small remote Pacific islands are sometimes marked with irregularly disposed white patches. These pie-bald birds, like light-coloured pheasants, cream-coloured partridges and dun-coloured rooks, may also be the victims of close inbreeding.

The Swamping Effects of Intercrossing.

The question "Are new varieties liable to be swamped by intercrossing?" is perhaps the most important now pressing for an answer from biologists. What would happen, for example, if specimens of all the different breeds of cattle were set free and left unmolested on a large area? Would they some centuries hence be represented by several breeds or by one? Many would answer this question by saying that unless some of them in course of time were isolated by mountains, deserts, or other physical barriers, they would eventually through intercrossing give rise to a single breed. To this question Darwin would, I think, have given a somewhat different answer, for, while admitting "that isolation is of considerable importance in the production of new species," he was, on the whole, "inclined to believe that largeness of area is of more importance ("Origin of Species," p. 104). Unfortunately Darwin nowhere indicates how he supposed new varieties escape being swamped by intercrossing. His silence on this important point is difficult to explain, for during his lifetime the influence of intercrossing in checking progress except in one direction was often enough insisted on. Huxley tells us that in his earliest criticisms of the "Origin" "he ventured to point out that its logical foundation was insecure so long as experiments in selective breeding had not produced varieties which were more or less infertile" ("Life of Professor Huxley," p. 170). Later Moritz Wagner and others pointed out the important part physical isolation had played in the origin of species; and later still Romanes endeavoured to show how the blighting influence of free intercrossing might be overcome by physiological selection, Romanes, like Huxley, believing several varieties might be evolved in the same area if more or less mutually infertile. Evidence of the importance of physical isolation is plentiful enough; but neither has experimental nor selective breeding proved that physiological isolation has been instrumental in arresting the swamping effects of intercrossing. Hence, according to Huxley and others, the foundation of Darwin's doctrine of natural selection must still be regarded as insecure. Is intersterility the only possible means by which new varieties can be saved from premature extinction, from being destroyed before they have a chance of proving their fitness to survive? In other words, are barriers as essential among wild as among domestic animals? It does not seem to have occurred to the biologists who so fully realised the need of isolation that the old varieties instead of swamping might be swamped by the new, and that several varieties might sometimes be sufficiently exclusive to flourish and eventually give rise to a like number of species in the same area. If on an island two new varieties of sheep appeared sufficiently vigorous, or, as we say, sufficiently prepotent, to swamp all the other varieties—as the ill-favoured lean kine did eat up the fat ones—and yet so exclusive that their cross-bred offspring invariably belonged to the one new variety or the other, for their preservation fences and other barriers would be superfluous.

Is there any evidence that by prepotency the swamping of new varieties is sometimes checked, and that by exclusive inheritance two or more varieties, though mutually fertile, may persist in the same area, occasionally intercrossing with each other, but neither giving up nor taking from each other any of their distinctive characters? I have in my possession a skewbald Iceland pony that produces richly striped hybrids to a zebra, but skewbald offspring the image of herself in make, colour, and temperament to whole-coloured bay Arab and Shetland ponies. This pony instead of being swamped invariably swamps older breeds. A number of prepotent skewbald ponies, wherever placed, would (especially with the help of preferential mating) in all probability soon give rise to a distinct race such as once existed in the East. What is true of the Equidæ is equally true of other groups. Black hornless Galloway bulls are often so prepotent that their offspring with long-horned brightly-coloured Highland heifers readily pass for pure-bred Galloways. The wolf is so prepotent over the dog, as the wild rabbit, rat, and mouse are prepotent over their tame relatives. As an instance of prepotency in rabbits, I may give the results of an interbreeding experiment with a grey doe, the granddaughter of a wild rabbit, and an inbred buck richly spotted like a Dalmatian hound. Of six young in the first litter three were like the sire. To one of her sons, the grey doe next produced eight young, all richly spotted, and subsequently to one of her spotted grandsons she produced two spotted, two white, and two grey offspring. Similar results are obtained with plants; hybrid orchids, *e.g.*, sometimes reproduce all the characters of one of the parents.

It need hardly be insisted on that if new varieties, well adapted for their environment, are not only sufficiently prepotent to escape being swamped by other varieties, but are also, like the spotted rabbit, able to hand on the prepotency almost unimpaired to a majority of their descendants, progressive development along a definite line will be possible. But of even more importance than prepotency is what for want of a better name may be known as exclusive inheritance. Recently a vigorous mature Indian blue-rock pigeon mated with an inbred and equally mature fantail, hatched and reared two birds, one exactly like a blue-rock, but with fourteen instead of twelve tail feathers; the other characterised by all the points of a high-class fantail, the tail feathers being thirty in number—two fewer than in the fantail parent, but eighteen more than in the blue-rock parent. In this case the blue-rock was the exclusive bird, the fantail having previously produced birds with only sixteen feathers in the tail when mated with an ordinary dovecot pigeon. A still more striking example of exclusive inheritance we have in the crow family. The carrion crow and the hooded crow are so unlike in colour that they were long regarded as two distinct species; now they are said to be two varieties of the same species. The carrion crow is black all over, but in the hooded crow the breast and back are grey. These two crows cross freely (but for this they would probably still rank as distinct species); but in the crossbred young there is never any blending—they are either black or grey, usually both varieties occurring in the same nest. Similar exclusiveness occurs amongst mammals. When distinct varieties of cats are crossed, some of the young usually resemble one breed, some the other, and the distinctions may persist for several generations. A white crossed with a tabby-coloured Persian cat produced a pair of white and a pair of tabby-coloured young; the two white cats when interbred also produced two white and two tabby-coloured individuals. I find cats are far more exclusive than rabbits; perhaps it is partly for this reason we have so many species and varieties of wild cats, so few species and varieties of wild rabbits. Another very striking instance of exclusiveness we have in the Ancon or "Otter" sheep common in New England at the end of the eighteenth century. This breed, which was characterised by short crooked legs and a long back like a turnspit dog, descended from a ram-lamb born in Massachusetts in 1791. The offspring of this "sport" were never intermediate in their characters; they were either like the original Ancon ram or like the breeds, some thirteen in number, with which he was mated. Frequently in the case of twins one was otter-like, the other an ordinary lamb. More remarkable still, the Ancon-like crosses, generation after generation, were as exclusive as their crooked-legged ancestor.

Another familiar example of exclusiveness we have in the peppered moth, a dark variety of which in a few years swamped the older light variety throughout a considerable part of England, and is now extending its range on the Continent. It thus appears that when a new variety is sufficiently prepotent, instead of being swamped it may actually swamp the old-established variety; and that when two or more varieties are sufficiently exclusive they may flourish side by side, and eventually give rise to two or more distinct species.

Prepotency may hence be said to supplement and complete the work of the environment. The environment seems to be mainly concerned in eliminating the unfit; whether any of the survivors persist depends not so much on their surroundings as on whether they are sufficiently prepotent and exclusive to escape being swamped by intercrossing. This way of accounting for progress in one or more directions may prove as inadequate as the one suggested by isolationists, but it has the merit of being more easily tested by experiment. It not only gets rid of the swamping bugbear, but makes it matter of indifference whether (to quote from the President's address at the last Oxford meeting of the Association) "the advantageously varied bridegroom at the one end of the wood meets the bride, who, by a happy contingency, had been advantageously varied in the same direction, and at the same time, at the other end of the wood." Further, as a highly prepotent vigorous variety can well afford to maintain a number of budding organs, it helps us to understand how luminous, electric, and certain other structures were nursed up to the point when they began to count in the struggle for existence.

Doubtful Causes of Variation.

Having indicated how maturity of the soma and of the germ-cells, and how bodily welfare and interbreeding may act as causes of variation, and also how swamping of the new variations may be checked, I shall now refer to certain supposed causes of variation.

Maternal Impressions.

I may begin with the widespread belief that the offspring are capable of being influenced in form, colour, and temperament by maternal impressions—the belief we associate with the skilful shepherd who peeled wands and stuck them up before the fulsome ewes. Muller ("Elements of Physiology," vol. ii. p. 1405) more than half a century ago, conclusively argued against the belief in maternal impressions, but the belief still prevails. I know of two able naturalists who subscribe to the maternal impression doctrine, and it is firmly held by many breeders and by not a few physicians. A writer in a recent number of a quarterly (*Bibby's Quarterly*, Autumn Number, 1900, p. 163), which circulates widely amongst farmers and stock-keepers, boldly asserts that the existence of impressions which affect progeny (more especially in colour) is a settled fact. This writer supports his case by referring to a highly successful breeder of polled Angus cattle, who considered it necessary to surround his herd "with a tight black fence in order to keep the females from dropping red calves because they saw the red herds of his neighbours." Reference is also made by this writer to the belief, common in certain parts of England, that whitewashed byres, regardless of the colour of the parents, produce light-coloured calves; that the colour of foals is often more influenced by the stable companion of the dam than by her own colour or that of the sire; and that even the colour of birds varies with the immediate surroundings, fowls, *e.g.*, however carefully penned, hatching birds resembling in colour the hens they habitually see in a neighbouring run. If maternal impressions thus influence the offspring they must be one of the most effective causes of variation. During the last six years I have bred many hundreds of animals, but the nearest approach to an instance of maternal impressions was a dark pup with a white ring half round the neck, which suggested the white metal collar sometimes worn by his sire. But similar rings round the legs and tail rather discredited the view that the white neck-ring was in any way related to the sire's nickel-plated collar. Telegony was sometimes said to be due to maternal impressions. It was doubtless for this reason that I was urged some years ago to carefully prevent the mares used in my experiments from seeing too much of the zebras. But though numerous foals have been bred from mares stabled with zebras or grazing with richly striped zebra hybrids, not a particle of evidence have I found in support of the maternal impression doctrine. The foals have neither stripes nor upright manes, and do not even attempt to mock the weird barking call of the zebra. Sheep and cattle, goats, rabbits and guinea-pigs, fowls and pigeons, have simply confirmed the results obtained with horses. This being the case, grooms may very well omit following the practice (considered so essential in Spain during the Middle Ages, and still often religiously observed in England and America) of setting "before the mares . . . the most goodly beasts" by way of hinting to them the kind of foals they are expected to produce.

The Needs of the Organism as a Cause of Variation.

No recent biologists are perhaps prepared to believe like Lamarck that the wings of birds were developed by their remote ancestors making efforts to fly; that by stretching its toes the otter acquired webbed feet; nor are they prepared to find in our new mammal, the Ocapi, evidence in support of Lamarck's contention that to meet new needs the giraffe by much stretching gradually lengthened his neck. Yet it is difficult sometimes to see any real difference between the beliefs of the new Lamarckians and the old. It is maintained, for example, "that when a certain functional activity produces a certain change in one generation it will produce it more easily the next," that, *e.g.*, flounders and their allies by constant efforts generation after generation have dragged the left eye to the right side, while by similar efforts in the turbot and certain other flat fishes the right eye has been shifted to the left side. It is not alleged by Neo-Lamarckians that globe fishes resulted from round fishes blowing themselves out, or that flounders resulted from round fishes generation after generation making efforts to flatten themselves. If by germinal variation and selection flounders were evolved out of round fishes, is it not straining at a gnat and swallowing a camel to refuse to admit that by the same factors the left eye of the flounder has been transferred from the left to the right side of the head? In the flat fishes it is not difficult to imagine how by variation and selection the eyes originally acquired the power of responding to certain external stimuli.

The Direct Action of the Environment and Use-Inheritance as Causes of Variation.

Of the doctrine of the transmission of acquired characters, still so often the subject of discussion, I need say little more than that I have failed to discover any evidence in its favour. Writing in 1876, Darwin says, "In my opinion the greatest error which I have committed has been not allowing sufficient weight to the direct action of the environment, *i.e.*, food, climate, &c., independently of natural selection" ("Life and Letters": Letter to Moritz Wagner). Darwin not only in his later years reverted to the teaching of Buffon, but in as far as he continued to believe in the "inherited effects of use and disuse" he adopted the views of Erasmus Darwin and Lamarck. While admitting that the direct action of the environment on the soma and use-inheritance are indirect—it may be potent—causes of variation, I do not believe there is any trustworthy evidence in support of the view that definite somatic variations are ever transmitted.

Telegony as a Cause of Variation.

The belief in telegony is less deserving of consideration than the doctrine of the transmission of acquired characters. Nevertheless I perhaps ought to refer to it at greater length, not so much because of its scientific importance, but because it interests all sorts and conditions of men in many different parts of the world. Telegony ("infection of the germ" of older writers) means that not only the immediate parents but also the previous mates (if any) contribute to the characters of the offspring; that, *e.g.*, a mare which had produced foals to, say, "Ladas" and "Persimmon" might thereafter give birth to a foal by "Flying Fox," to which "Ladas" and "Persimmon," as well as the actual sire, contributed some of their characteristics. Many even think a sire may transmit definite structural characters from one mate to another. If there is such a thing as telegony, if it is possible to blend without the risks of intercrossing the characteristics of several individuals or varieties, progressive development would be greatly accelerated. Though the doctrine of "infection" has probably long formed part of the breeder's creed, it received but little attention from men of science until in 1820 Lord Morton communicated a case of infection to the Royal Society, which in due time was published in the *Philosophical Transactions*. In this the most credible and best authenticated of all the cases of telegony on record a chestnut mare, after rearing a quagga hybrid, produced to a black Arabian horse three foals of a peculiar bay colour, one of them (a filly) showing more stripes than the quagga hybrid, and, according to the stud groom in charge of "the colts," characterised by a mane "which from the first was short, stiff, and upright" (*Phil. Trans.*, 1820, p. 21). Darwin, after fully considering Lord Morton's case, came to the conclusion that the chestnut mare had been infected, and this case along with others led him to believe that the first male influenced "the progeny subsequently borne by the mother to other males" ("Animals and Plants," vol. ii, pp. 435, 436.) If the upright zebra-like mane in one of the pure-bred colts and the markings on all three were the result of the chestnut mare having been first mated with a quagga, there is undoubtedly such a thing as telegony, and the presumption is that other mares first mated with a quagga or zebra and then with a black Arabian would give birth to striped offspring with a stiff if not quite upright mane. The evidence that from the first the mane of the filly was short, stiff, and upright is most unsatisfactory. It consists of an allegation by a stud groom. That the mane was upright, as in the quagga and zebra, is *a priori* improbable (1) because the mane of the quagga hybrid instead of being short and stiff was long and lank enough to arch to one side of the neck; (2) because the mane of zebra hybrids throughout the greater part of the year is so long that it falls to one or it may be both sides of the neck; and (3) because in the Equidæ an upright mane is always accompanied by a tail deficient of hairs at the root—in the filly the tail is as perfect as that of her Arab sire. We have still stronger evidence that the allegation of the groom was unfounded from drawings (of the chestnut mare, her three "colts," the black Arab, the quagga, and the quagga hybrid) by Agasse, a very trustworthy animal painter of the early part of last century. In the drawing of the filly the mane is represented as lying to one side, as in Arabs and other well-bred horses. The pictures (now in the Museum of the Royal College of Surgeons, London) were made because the subsequent foals were believed to prove the truth of the "infection" doctrine. Had the mane of the filly been erect it would hardly have escaped the keen eyes of the artist. But had Agasse by any chance missed this all-important detail, Lord Morton or some of those interested would doubtless have called his attention to the matter. If the mane of an Arab is completely removed early in the spring it is stiff, and upright in the autumn, but hanging to one side close to the neck in the following summer. When the whole circumstances are taken into consideration, there seems to me no escape from the conclusion that the mane of the filly was upright when seen by Lord Morton in August, 1820, and lying to one side when painted by Agasse the following summer, because it had been regularly cropped or at least hogged some months before Lord Morton's visit. But whatever be the explanation of the want of agreement between the mane as seen by Lord Morton and as depicted by Agasse, it will, I think, be admitted that the evidence afforded by the mane of the filly is hardly sufficient to establish the truth of the doctrine of telegony. Of still less value is the evidence afforded by the make, coat, colour and markings which were apparently too indistinct to deserve the name of stripes. The colts were decidedly Arab-like, of a bay colour marked more or less "in a darker tint." Judging from Agasse's drawings they closely resemble Arab-Indian crosses; they are, in fact, in make very like the Arab-Kattiawar horse already referred to. I have seen a bay Highland cob with as many stripes as Lord Morton's colts, and pure-bred Arabs of a dun colour with stripes on the neck and far more distinct leg bars than those depicted by Agasse. I believe the colts owed their stripes and colour not to "infection" of their dam by her previous mate the quagga, but to reversion. It is quite possible the black Arabian horse was of mixed origin; that the chestnut mare was crossbred is admitted. As in the west of Ireland the offspring of black and chestnut ponies are sometimes of a decidedly dun colour, it is not surprising that the black Arab and the half-bred chestnut had bay offspring. Neither are the stripes surprising. I recently ascertained that the chestnut mare was presented to Lord Morton (while serving with his regiment in India) by one of his officers—Mr. Boswell, of Deeside, Aberdeenshire—and that she was most likely a cross between an Arab and a country-bred pony. In Kattiawar the ponies when pure-bred are of a rufous grey colour and more or less richly striped. If in the chestnut mare there was any Kattiawar or even any native pony blood its offspring to a black sire might have been expected to be of a dun colour and striped. In a word, there is no reason for assuming that the foals would have been less striped if the chestnut mare had been mated with the black Arab first and the quagga afterwards.

By way of testing the truth of the "infection" doctrine I started, in 1895, a number of experiments, and especially arranged to repeat as accurately as possible, what is commonly called Lord Morton's experiment. Since then twelve mares after producing sixteen zebra hybrids, a mule, and a hinny have had an opportunity of supporting the telegony hypothesis by giving birth to twenty-two pure-bred foals.

During the same period Baron de Parana of Brazil has bred at least six zebra hybrids, and some of the dams of these hybrids subsequently produced ordinary foals. Further, Baron de Parana has for a number of years been engaged in crossing cattle and in watching the results obtained in several mule-breeding establishments, where from 400 to 1000 brood mares are kept. As in these establishments the mares breed mules and horses alternately—two or three mules and then a horse foal—there has been carried on for some years, under the observation of Baron de Parana, a telegony experiment on a gigantic scale.

The single hybrid bred by Lord Morton had extremely few stripes, and only in a remote way suggested a member of the zebra family. All my hybrids, like those bred in Brazil, have more stripes than their zebra sire, and in some of them the bands are nearly as conspicuous as in some of the zebras, thus proving that both the mares (which varied in colour and breed) and the two zebra stallions used were well adapted for the experiment. The results of my experiments, not only with the Equidæ but also with other domestic quadrupeds and birds, all point to the conclusion that there is no such thing as telegony, and the same conclusion has been independently arrived at by Baron de Parana in Brazil. Believers in telegony—they are numerous in America, India, and Australasia, as well as in England—almost always say of the many experiments recently made with a view to giving "infection" a chance of showing itself that they have only yielded negative results, and they generally add, it is impossible to prove a negative. After carefully considering all the more striking so-called cases of "infection," I have no hesitation in saying that there is no satisfactory evidence that there has ever been, either in the human family or amongst domestic animals, a single instance of infection.

I have in a hurried and imperfect manner indicated that we are not likely to find either in maternal impressions, the direct action of the environment, use-inheritance, or telegony a true cause of variation. I have endeavoured to point out that, instead of simply stating that variation is due to the constant recurrence of slight inequalities of nutrition of the germ-cells, we may with some confidence assert that differences in the age, vigour, and health of the parents and differences in the ripeness of the germ-cells are potent causes of variation.

I have also endeavoured to prove that intercrossing, though a *direct* cause of retrogressive variation, is only an *indirect* cause of progressive variation, while interbreeding (in-and-in-breeding) at the right moment is a cause of progressive variation.

Further, I have discussed at some length the swamping effects of intercrossing, chiefly with the object of showing (1) that progress in a single direction is probably often due to new varieties swamping old, it may be long established, varieties; and (2) that several varieties may be sufficiently exclusive to flourish side by side in the same area, and eventually (partly owing to their aloofness, *i.e.*, to differential mating) give rise to several new species.

I have only now to add that I was mainly led to select "The Experimental Study of Variation" as the subject of my address that I might indirectly indicate that the time had come when a well-equipped institute should be provided for biological and other experiments.

NOTES.

THE *Times* announces that the Indian Government have adopted the suggestion of the Royal Society for the carrying out of a magnetic survey. The existing magnetic observatories at Bombay and Calcutta being inadequate as base stations for the vast area the survey will cover, similar observatories are in course of construction at Dehra Dun, at Kodaikanal, and at Rangoon. The Dehra Dun observatory will be under the supervision of Colonel Gore, R.E., the Surveyor-General of the Indian Survey (whose headquarters are located there); but the other four will be in charge of Mr. John Eliot, the meteorological reporter to the Government. The Survey and Meteorological Departments will, in fact, be jointly responsible for the investigations. The field observations will be carried out by six or seven detachments of the Survey Department, and these will be controlled by Captain Fraser, R.E., who has recently been arranging in England for the purchase of the necessary instruments. Sind and the Punjab will first be taken in hand; and, as the country is now intersected with railways in all directions, enabling field detachments to quickly cover the distances from one observing station to another, it is anticipated that five years will suffice to complete the field work of the preliminary magnetic survey.

IT is stated that a committee is being formed at Amalfi to arrange for the celebration of the fourth centenary of the invention of the compass. The Duke of the Abruzzi has agreed to be president of the committee, and Signor Morin, the Minister of Marine, the vice-president. The celebration will take place next year.

To obtain information for the Lightning Research Committee organised by the Royal Institute of British Architects and the Surveyors' Institution, the Institution of Electrical Engineers has sent papers of questions to the secretaries of local branches abroad, and it is hoped that members resident in districts outside Great Britain will cooperate in the work.

THE gold medal of the Italian Science Society has been presented to Mr. Marconi in London for his services in the invention of wireless telegraphy. The medal was entrusted by the Minister for Foreign Affairs in Rome to the Marquis Luigi Solari di Loreto, an officer in the Italian navy. Count Vinci, Chargé d'Affaires of Italy in London, and Cav. P. T. Righetti, Vice-Consul, were also present. The Marquis Solari, in handing the medal to Mr. Marconi, expressed the admiration of Italy for her distinguished son, whom the whole country remembered with pride and delight. Mr. Marconi, in reply, stated that among the many marks of distinction conferred on him he prized none so much as those which came from his beloved native land.

M. SANTOS DUMONT made an ascent with his new steerable balloon on Friday last, and though he was successful in navigating the balloon, an accident occurred owing to one of the guide-ropes getting caught among some trees. He hopes to make another ascent in a week or so. The Paris correspondent of the *Times* says that the scientific committee of the Aëro Club has resolved that the competitors for the Deutsch Prize must not only return to the starting-point within twenty minutes after rounding the Eiffel Tower, but must actually touch ground in the Aëro Club enclosure. Mr. William Beedle, whose balloon is now being rapidly got ready at the Spencer Works, intends to be in Paris towards the end of October to try for the prize. He has a more powerful motor than that of M. Santos Dumont, 28-horse power, and a tougher envelope protected, and, it is believed, so arranged under an aluminium framework as to secure perfect rigidity for all practical purposes.

THE fifth International Congress of Criminal Anthropology was opened at Amsterdam on Monday last. Among the papers contributed was one by Prof. Lombroso, on the latest anatomical researches into degeneration and on tattooing.

WE regret to notice the announcement of the death, on the 7th inst., of Dr. John Louis William Thudichum, well known for his researches in organic and physiological chemistry.

THE late Mr. H. M. Courage, of Snowdenham Hall, Bramley, has left the whole of his valuable collection of birds, numbering between 6000 and 7000 specimens, to the governors of Cheltenham College. A few years before his death, which occurred last month, Mr. Courage presented a representative collection of British birds to the Hobart Museum, Tasmania.

THE Baumgartner prize of the value of 2000 crowns will be awarded at the end of 1903 by the Vienna Academy of Sciences for a research enlarging our knowledge of the invisible radiations.

Science announces that the Veitch silver medal for distinguished services in botany and horticulture has been awarded to Mr. Thomas Meehan, of Philadelphia.

THE Surrey County Council have taken a practical step in the direction of the prevention of tuberculosis by the issue of a leaflet dealing with the character of the disease, its great mortality, the manner in which it is spread, and the precautions which should be taken to prevent infection. This leaflet has been drawn up by the county medical officer, Dr. Seaton, acting on the instructions of the sanitary committee of the County Council, and local authorities throughout the county have been asked to cooperate in the dissemination of this information to every household in Surrey. The committee recommend all sanitary authorities to inform medical practitioners in their districts that, after the death or removal of a patient suffering from the disease, they will undertake disinfection of the premises at their own cost.

AN analysis of dust which fell at Fiume, Hungary, on March 10–11, and was described as showers of "red or blood rain" over a large part of Southern and Central Europe, was made by M. M. Barac, and the results are given in the number of the *Journal* of the Royal Meteorological Society just issued (vol. xxvii. No. 119). It will be remembered that some of the dust was collected by Prof. Rücker at Taormina, and described by Prof. Judd in these columns on March 28 (p. 514). M. Barac's chemical analysis gave the following percentage composition for the material:—Silica, 49·49; iron sesquioxide, 9·96; alumina, 12·10; manganese peroxide, 1·99; lime, 11·46; magnesia, 0·40; carbonic acid, 8·96; organic matter, 5·48; traces of soda, sulphuric acid, hydrochloric acid, &c., 0·16. Under the microscope, with a power of 640, M. Barac found the main mass to consist principally of colourless and, in less degree, of coloured particles, of irregular shape, partly angular fragments of crystals, and also mineral particles. In addition there were siliceous skeletons of micro-organisms, and, finally, particles of soot. There were a few well-formed rhombohedra of calcite and cubes of common salt; and both the calcite and the quartz crystals exhibited chromatic polarisation. As regards magnitude, the minimum was 0·001 mm., the average 0·017 mm., and the maximum among the crystalline particles 0·051 mm.; while the yellow structureless mineral particles attained the size of 0·113 mm.

MAJOR RONALD ROSS, F.R.S., has sent a letter to Mr. A. L. Jones giving some particulars as to the results of his visit to the Gold Coast and the work of the fifth expedition of the Liverpool School of Tropical Medicine in Sierra Leone. He says that at Sierra Leone he found Dr. Logan Taylor pushing on the operations against mosquitoes with great vigour. A report received a few days ago from Dr. Logan Taylor states that 5000 houses in Freetown have been cleared of vessels of every description which previously served as breeding places for mosquitoes. What a serious blow this will be to the prevalence of the Culex mosquito in Freetown will be readily understood. The result is already well marked, and there is undoubtedly a great reduction in the number of these insects in the centre of the town generally. Of course, the insects will still occur for some time here and there, but their breeding places can be easily detected and abolished. To judge of the value of these operations it must be remembered that besides causing constant annoyance to everyone, the insects carry the germs of yellow fever, elephantiasis, and perhaps other diseases. Operations against the Anopheles mosquito (which breed in puddles on the ground) are also being well pushed by Drs. Taylor and Berkeley. Hollows in the ground are everywhere being drained away or filled up with rubble and earth. Others are being filled with the empty bottles and tins found in the houses. Many of the worst streets, which formerly were practically marshes in the rains, have been reclaimed. Major Ross says it is now a matter of some difficulty to catch Anopheles for scientific examination, and it seems that a little perseverance will ultimately abolish these malaria-bearing insects as a disease factor in Freetown. Major Ross remarks in conclusion that the unhealthiness of the Coast has been much exaggerated. True, there is a considerable amount of malaria among Europeans; but then there is little or no typhoid. He says that in nine cases out of ten if a man contracts malarial infection it is his own fault.

THE *Pioneer Mail*, Allahabad, states that Mr. Rea, superintendent of the Archæological Survey of Madras and Coorg, has discovered a field for exploration in the Tinnevelly district which promises to be of much interest and importance. The site, which is near Adichanallar, has been, Mr. Rea thinks, at one time a very large town. "The deposits, if fully excavated, would, I have not the slightest doubt," says Mr. Rea, "stock several museums with unique objects of the most interesting description, for almost every excavation brings to light something not heretofore found. I have examined many prehistoric sites, but have never seen one so extensive and varied in its results as this. Extensive tracts are yet untouched. . . . Over 114 acres are now reserved, but the remains extend even beyond that area. It would require several years' steady work to completely explore the place. That this is by far the most important and extensive prehistoric burial place as yet discovered in Madras, I can certainly state." Some eighteen hundred curious objects in bronze, iron and pottery, as well as seven pure gold oval-shaped ornaments, have already been unearthed.

THE Grand Trunk Railway of Canada, according to the *Railway and Engineering Review*, has recently constructed, and commenced using, a car specially adapted for the distribution of live fish to waters along its lines. The interior of the car is arranged with a series of galvanised iron tanks to hold from 1000 to 1500 fish. At one end of the car is an upper and lower berth, like those in a Pullman car, to accommodate two men. Ice for keeping the water at a certain temperature is carried in two compartments built for this purpose and holding about one ton each. Arrangements have been made for replenishing the water in the tanks, *en route*, by attaching a hose to any of the hydrants at stations on the road.

THE Museum of the Literary and Philosophical Society of Hull has recently been taken over by the Corporation, and one of the first results is a note (*Yorkshire Naturalist* for August) by the Curator (Mr. T. Sheppard) on the type skeleton of Sibbald's rorqual, which forms one of the treasures of the collection. The animal to which this skeleton belonged was stranded in the Humber so long ago as 1835.

THE September issue of the *Entomologist's Monthly Magazine* contains the commencement of a series of articles on the insect fauna of the Balearic Islands, mainly based on collections made by Prof. Poulton and Messrs. Pocock and Thomas of the British Museum. Prof. Poulton himself contributes the introduction to the series, and he is followed by Mr. E. Saunders, who describes the bees, wasps, and their allies. In Majorca much of the original insect fauna appears to have been exterminated by agriculture, although much of interest will, it is hoped, still be found. In Minorca, where cultivation is not carried on to such an extent, insect life is probably much richer.

THE polychætous annelids of the Puget Sound region form the subject of a communication by Mr. H. P. Johnson published in vol. xxix. (No. 18) of the *Proceedings* of the Boston Natural History Society. Including two species from British Columbia sent by Prof. Herdman, the collection at the author's disposal comprises fifty-one species (many of which are new), classed in thirty-four genera. Nearly all the forms were collected between tide-marks, and only one is common to the Japanese coast. This latter fact is not surprising when it is borne in mind that the Puget Sound fauna is boreal, while the forms collected in Japan pertain to the Indo-Pacific fauna.

SOME time ago Prof. E. B. Poulton announced in these columns (vol. lx. p. 591) the discovery of two species of peripatus in the Siamese Malay States, this being the first record of the occurrence of this group on the Asiatic mainland. These two new forms, together with a third from Selangor, are described by Mr. R. Evans in the August number of the *Quarterly Journal of Microscopical Science*. This description has involved a reclassification of the group (Onychophora), and the author proposes the new generic title Eoperipatus for the Malayan (inclusive of the Sumatran) forms. Curiously enough, these are more nearly related to the Central American than to any other members of the group, although they are connected to a certain extent with the African forms through a species which is now assigned to a second new genus (Mesoperipatus). It is concluded that the birthplace of this very archaic group was probably Africa. In another article in the same journal Mr. S. B. Mitra, of Calcutta, discusses the function of the so-called "crystalline style" of the bivalve molluscs. After reviewing previous theories, the author comes to the conclusion that this remarkable rod-like body (which in the common pond-mussel is three-fourths the entire length of the animal) really acts as a digestive ferment whose function is to convert starch into sugar.

THE services which anthropometry renders to physical education are dealt with by Major Dr. Paul Godin in the *Bulletins et Mémoires* de la Société d'Anthropologie de Paris (5e série, tome ii. 1902, fascic. 2, p. 110), whose paper is fortified by numerous tables and graphic curves.

THE development of illumination, or rather the evolution of artificial illumination, is the subject of a short paper by Mr. Walter Hough in the *American Anthropologist* (N.S., vol. iii. 1901, p. 342), in which he epitomises the stages in the development of the candle and of the lamp. It is only comparatively recently that the latter has improved beyond a very simple and inefficient contrivance; at present the destiny of illumination is in the hands of the investigator and inventor.

UNDER the title of "Les Peuplades de Guinée" (*Revue Scientifique*, 4e Sér. T. 16, No. 8, p. 233), M. A. Vergely gives an account more particularly of the Soussous (Susu), who he thinks have been greatly calumniated. He describes their appearance, mental traits, clothing, mode of life, morality, and other social characteristics, and contrasts with them the Foullas (Fulah); the former are true negroes, the latter are Hamites. This comparison of two very different people living under the same conditions is very suggestive.

THERE have been several theories for the origin of the word "Surrey." Mr. T. le Marchant Douse, in the *Home Counties Magazine* (vol. iii. No. 11, July 1901, p. 198), follows up the suggestion of Kluge, and produces an array of evidence that supports his contention that it means the land of the South Rige, who are identified with the Rugii of Tacitus. The oldest known habitat of the Rugi was by the mouth and lower course of the Oder, probably to the east of it. Very early in our era the Goths wholly or in part dispossessed them; some migrated southward, others westward and north-westward, and it is extremely probable that the Baltic Rugi in the fifth century joined other adventurers, but under their own chief or king, and settled in England. Surrey continued to be called a "kingdom" long after it had ceased to have a king to itself. Eastry, near Sandwich in Kent, is now a large village and parish, but was formerly a town and district; in a charter of 788 this is spoken of as "the district of the Eastriges."

IN the current number of the *Bulletins et Mémoires* de la Soc. d'Anthropologie de Paris (5e série, tome ii. 1902, fascic. 2) there are two illustrated papers, by Dr. Atgier, on deformed heads of living subjects: the one is a case of oxycephaly or acrocephaly and the other of scaphocephaly. The discussions on these cases is as important as the original papers. M. Pelletier proposes (p. 188) a new method of obtaining the cubic index of the skull. It is sometimes impossible to measure the cubic capacity of a skull by the ordinary methods, and always to do so in the case of the living, so recourse has to be made to an estimation of the capacity from certain measurements. Those in vogue are the glabella-occipital length, the greatest breadth and the basio-bregmatic height. The author proposes the ophryo-occipital length, the greatest breadth and the auriculo-bregmatic height; for, as he justly observes, these can also be made approximately on the living. We are glad to find that the auricular height, which has been employed by one or two British anthropologists, is recognised as of more value than the basial height. Those who are interested in this subject should also consult the recent noteworthy investigations by Alice Lee and Karl Pearson on the determination of capacity of the human skull from external measurements (*Phil. Trans. Roy. Soc.* series A, vol. cxcvi. pp. 225-264, "Data for the Problem of Evolution in Man; vi. A First Study of the Correlation of the Human Skull").

AN appreciative article on the life and work of Prof. T. G. Bonney, F.R.S., appears in the September number of the *Geological Magazine*, being the first of what is apparently to be a series of biographies of eminent living geologists. The article is accompanied by a portrait of Prof. Bonney, reproduced as a full-page plate.

THE first part of a work on European butterflies—"Die Schmetterlinge Europas"—by Dr. A. Spuler, forming the third edition of E. Hoffmann's treatise, has been received. It is intended to complete the work in thirty-eight parts, which together will contain descriptive text and nearly a hundred plates having about 2700 coloured pictures of butterflies upon them. The book will be noticed when all the parts have been received. Messrs. Heyne Brothers are the English publishers.

THE Annual Report of Mr. J. C. Smock, the State Geologist of New Jersey, contains important articles on the Portland Cement Industry and on the Iron and Copper Mines by Dr. H. B. Kümmel, and on Artesian Wells by Mr. Lewis Woolman. One boring in Atlantic City has been carried to a depth of 2285 feet, and is still being drilled; so far without success. Mr. W. S. Myers contributes a short article on Chlorine in the Natural Waters of the State, and draws attention to its importance in the examination of waters suspected of contamination by sewage.

THERE is an interesting sketch of the vestiges of the ancient settlement of the Northmen in the Isle of Man, by Anton Weis, in *Globus* (Band lxxx. No. 7, p. 113), but the author makes a remarkable slip when he states that "this little island is only four to five miles long and two miles broad."

THE additions to the Zoological Society's Gardens during the past week include a Jaguar (*Felis onca*, ♀) from South America, presented by Mr. F. W. Barrow; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. A. N. Owen; an Egyptian Jerboa (*Dipus aegyptius*) from Egypt, presented by Miss A. Moore; a Tawny Owl (*Syrnium aluco*), British, presented by Mr. T. E. Gunn; a Green Turtle (*Chelone mydas*) from the Tropical Seas, presented by Captain Stevenson; a Madagascar Tree Boa (*Corallus madagascariensis*), a Madagascar Boa (*Boa madagascariensis*), eight Sharp-headed Snakes (*Lioheterodon madagascariensis*) from Madagascar, a Chameleon (*Chamaeleon vulgaris*) from North Africa, deposited.

OUR ASTRONOMICAL COLUMN.

OPPOSITION OF EROS IN 1903.—The planet Eros has now so nearly approached the sun that further observations of its light have become impossible; but as the amount of material accumulated since the discovery of its variability in brightness is not sufficient for determining satisfactorily the laws governing it, full advantage of all the future opportunities of observing the body should be taken.

Since three times the tropical period is about seven years, the favourable conditions of 1893 and 1900 will not be repeated until 1907. The coming opposition in 1903 will be similar to that of 1896, and although not specially favourable, may possibly give opportunities for useful measurements. With this end in view, Prof. Pickering has issued an ephemeris showing the computed path of the planet during the years 1901, 1902 and 1903, the accidental errors of which have been eliminated as far as possible. The magnitudes given are not corrected for phase, and are based on the assumption that the magnitude at unit distance = 11·39. From these tables it appears that the next most favourable time of observation will be during the spring of 1903, and preparations are being made for an extensive series of photometric measures at Arequipa during that period. (*Harvard College Observatory Circular*, No. 61).

RADIAL VELOCITY OF 1830 GROOMBRIDGE.—An interesting investigation is reported by Prof. Campbell, bearing on the spectroscopic determination of the velocity in the line of sight of 1830 Groombridge, the star which, until lately, had the largest known proper motion (7″·05 per year). Although the various determinations of the parallax of this star differ somewhat in value, they all agree in placing the star at a great distance, Newcomb's adopted parallax being 0″·14. Assuming this as the true value, the component of the star's velocity *perpendicular* to the line of sight will be 240 kilometres (150 miles) per second. The component of its velocity *in* the line of sight has been determined from *four* photographs of its spectrum taken with the Mills spectrograph; the results from all are substantially in agreement; the best values are :—

Date.	Velocity. Kilometres.	Miles.
1901 March 18	−93	−58
April 1	−97	−60

The mean value of the radial velocity is taken as -95 ± 5 kilometres per second (equivalent to 59 miles per second approach). The spectrum is approximately of the solar type, inclining rather to the characteristics of Procyon or α Persei. The best photograph was obtained with an exposure of two hours (*Lick Observatory Bulletin*, No. 4).

NOVA PERSEI.—MM. Flammarion and Antoniadi give some further particulars in the *Astronomische Nachrichten* (Bd. 156, No. 3736) respecting the peculiar appearance of the Nova. The photographs of the star region were obtained with an Hermagis photographic objective of 16 cm. aperture and 70 cm. focal length.

Three proofs on paper have been examined, both enlargements and direct prints. That from the plate obtained on August 19, with an exposure of 30 minutes, shows that the image of the new star is very different in appearance to the images of neighbouring stars, being surrounded by a strong penumbra with a sharp edge, the mean diameter of which is about 2′ of arc. Another from a negative which was exposed for a much longer period, 3h. 20m., shows the image of the star encroaching on the first penumbra, but beyond this there is shown a much larger aureole, some 6′ of arc in diameter, and the appearance is said to resemble the umbra and penumbra of a sunspot.

VARIABLE RADIAL VELOCITY OF δ ORIONIS.—The variable velocity of this star was discovered by M. Deslandres from observations made with a spectroscope attached to the great Meudon refractor. The star is not quite suited for this type of investigation, as the lines are broad, but three observations secured during 1900 confirm M. Deslandres' results.

The velocities reduced from these were :—

1900 August 12	+3	kilometres per sec.
" 21	+51	" "
Sept. 17	−69	" "

(*Lick Observatory Bulletin*, No. 4.)

IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute was held on September 3 and 4, in conjunction with the International Engineering Congress, at the University of Glasgow, and was very largely attended. After speeches of welcome, the president, Mr. W. Whitwell, delivered a short introductory address, in which he dwelt upon the advantages to be expected from the fact that the Iron and Steel Institute met for the first time in its history in conjunction with eight other societies, forming one great International Engineering Congress. In the overwhelming mass of matter published by these societies there was, he considered, a certain amount of overlapping that the Congress might tend to obviate in the future. Some of the papers, too, at first sight might appear to be of little practical importance. This criticism had frequently been applied to many of the papers read before the Iron and Steel Institute. It must be remembered, however, that this had been from time immemorial the favourite objection to the work of pioneers of thought.

The 30,000 pages published by the Iron and Steel Institute since its inauguration in 1871 afforded fruitful examples of the subsequent value of scientific researches, which, when first presented, were received with coolness and suspicion. Numerous examples might be cited. For instance, the microscopic method of investigating the structure of steel, created by Sorby, Martens, Osmond, Howe and Stead, had become an indispensable auxiliary to chemical analysis and physical tests in steelworks. The abstruse memoirs on the heat treatment of steel, and on pyrometry, had led to important practical applications, and the phase rule enunciated by the American professor, Gibbs, and applied by Sir William Roberts-Austen, Baron Jüptner, Le Chatelier and Stansfield would no doubt eventually prove of extreme value in elucidating some of the more intricate problems confronting the metallurgist.

The first paper was read by Mr. Walter Dixon. It contained a concise account of the iron and steel industries of the west of Scotland, drawn up by a committee of the local metallurgical society, pig iron being dealt with by Mr. Henry Bumby, wrought iron by Mr. W. Wylie, and steel by Mr. H. Archibald.

The second paper was also the report of a committee, presented by Mr. Bennett H. Brough, the secretary. In view of the fact that with the development of metallography the nomenclature was becoming more and more involved, the Iron and Steel Institute appointed a committee to consider the matter and to ascertain whether it would be possible to take steps to make the terminology less complicated and more precise. A glossary was submitted, containing the more important terms used by authors of memoirs dealing with metallography, in the hope of obtaining criticisms and suggestions in order that the committee might have before them data upon which to base their judgment. In each case the equivalents in French and German were added.

Mr. A. Wahlberg (Stockholm), then read a paper on variations of carbon and phosphorus in steel ingots. The object of his research was to establish the limits of variation of carbon and phosphorus in steel which has been cast into 10-inch ingots and then rolled into 4-inch billets, and to ascertain to what extent chemical analyses of identical samples vary in their results as regard the percentage of carbon and of phosphorus when made by different chemists. The material tested was procured from four works and was analysed in four laboratories. The variation in chemical composition in different portions of the billet and the divergent results obtained by different analysts were well shown in a number of tables. In the discussion which followed the reading of the paper, the need for standard methods of analysis was urged.

The meeting then adjourned until September 4, when Mr. C. H. Ridsdale read a lengthy paper of great practical interest on the correct treatment of steel. After a full discussion of this paper, Mr. J. E. Stead read an abstract of two papers. In the first, on copper and iron alloys, he reviewed the contradictory evidence in metallurgical text-books, and gave the results of his recent work. Copper and iron, he showed, alloyed most readily by direct fusion in all proportions. Such alloys might be classed in three main sections: (*a*) with traces to 2·73 per cent. of iron and 97·2 per cent. of copper, (*b*) with 8·0 per cent. of copper and 91·5 per cent. of iron, and (*c*) alloys intermediate between the two. The alloys of the first two sections are practically homogeneous, class *a* consisting of copper with iron in solid solution and class *b* consisting of iron with copper in solution. The alloys of the third class contain saturated solid solutions, copper in iron and iron in copper, separate from each other but in micro-juxtaposition. In solidifying the portion first to fall out of solution was the iron containing copper in solid solution. The conflicting character of evidence previously published was probably due to the fact that some of the investigators in the past had not taken the precaution to use iron free from carbon. The effect of carbon is marked. On heating the alloys containing more than 7·5 per cent. of copper to whiteness with charcoal, copper containing about 10 per cent. of iron is thrown out of solution and falls to the bottom, leaving a layer of carburised iron on the surface containing about 7·5 per cent. of copper.

In the next paper, Mr. J. E. Stead and Mr. F. H. Wigham described experiments on a series of steels with and without copper prepared by dividing the finished steel in each series when in a fluid state into two parts, to one of which copper was added in amounts varying between 0·46 and 2·0 per cent. Elaborate tests showed that copper in such large quantities does not improve the quality of the wire, but generally has a deteriorating influence, particularly in the presence of high carbon. The only good property exhibited by cupreous steel wire is that it resists corrosion.

Mr. G. Watson Gray then read a paper recording the occurrence of calcium in a ferro-silicon. He gave analyses of ferro-silicons containing 0·79 to 14·40 per cent. of calcium, and described a new method for the analysis of ferro-silicon.

A lengthy paper on the profitable utilisation of power from blast-furnace gases was read by Mr. B. H. Thwaite. One of the results following the use of blast-furnace gas for the direct production of power in internal combustion engines has been marked progress in the mechanical perfection of power capacities and in the thermodynamic efficiency of this engine. A new scheme for obtaining all the power possible from the blast furnace, devised by the author, includes the recovery of the sensible heat that is otherwise lost in cooling the blast-furnace gases, in heating the air to convert coal into gas in producers, and in supporting the combustion of the gases thus produced in hot-blast stoves. The various outlets for electric power that could be generated by the new system are described. The production of silicon and calcium carbides, of chromium, nickel and aluminium are instanced as being exceptionally suitable as associated industries for ironworks.

Prof. W. N. Hartley and Mr. H. Ramage next gave the results of an investigation of the spectra of flames at different periods during the basic Bessemer blow. The conclusion arrived at was that the phenomena of the basic Bessemer blow differ considerably from those of the acid process, in the following respects:—

First, a flame is visible from the commencement of blowing, or as soon as the cloud of lime dust has dispersed. We conclude that the immediate production of this flame is caused by carbonaceous matter in the lining of the vessel, that its luminosity is due partly to the volatilisation of the alkalis, and to the incandescence of lime dust carried out by the blast.

Secondly, volatilisation of metal occurs largely at an early period in the blow, and is due to the difference in composition of the metal blown, chiefly to the smaller quantity of silicon. There is practically no distinct period when siliceous slags are formed in the "basic" process, and metals are volatilised readily in the reducing atmosphere, rich in carbon monoxide.

Thirdly, a very large amount of fume is formed towards the close of the second period. This arises from the oxidation of metal and of phosphorus in the iron phosphide being productive of a high temperature, but little or no carbon remaining. The flame is comparatively short, and the metallic vapours carried up are burnt by the blast.

Fourthly, the "over-blow" is characterised by a very powerful illumination from what appears to be a brilliant yellow flame; a dense fume is produced at this time composed of oxidised metallic vapours, chiefly iron. These particles are undoubtedly of very minute dimensions, as is proved by the fact that they scatter the light which falls on them, and the cloud casts a brown shadow, and, on a still day, ascends to a great height. In a given flame the brilliancy of the line spectrum of potassium is increased by diminishing the quantity of metallic vapour in the flame; this does not appear to depend altogether on the weakening of the continuous spectrum which accompanies the line spectrum of potassium; some experiments made with various salts of potassium show that it is probably due, in part at least, to the increased freedom of motion permitted to the molecules of the metal.

Mr. A. Wahlberg (Stockholm) submitted the second portion of his elaborate memoir on Brinell's method of determining hardness and other properties of iron and steel. The first portion was read at the May meeting, and the two together constitute a monograph of about one hundred pages. The second portion dealt more particularly with the influence of different methods of annealing and hardening on the tensile properties of iron and steel determined by means of tensile tests, and with researches undertaken for the purpose of ascertaining the influence of chemical composition and various modes of treatment on the resistance to impact in iron and steel at ordinary and low temperatures.

Mr. Arthur Wirgham submitted a very suggestive paper on the internal strains of iron and steel and their bearing upon fracture.

The object of the paper was to assist the elucidation of some of the mysteries attendant upon the physical behaviour of metals generally, and of iron and steel in particular, and to throw light upon the cause of the sudden and unexpected breakages of metal used for machinery and other purposes. Its reasonings were based upon the following facts and hypotheses:—That there are two kinds of equilibrium to which a metal attains, viz., chemical and physical; that the natural tendency of a complex metal is to assume its most simple forms of combination preferentially capable of existing at a given temperature; that its rapidity of cooling, even under the slowest conditions, is too great to allow this to reach finality; that the equilibrium is further repeatedly interfered with by changes of atmospheric and other conditions; that the adjustment to physical equilibrium tends to assist the adjustment to chemical equilibrium; that adjustment which is assisted by slightly raised temperatures, also, as a consequence, takes place in the cold; and that the eutectic is the medium through which the chemical or molecular change takes place, working, of course, in conjunction with the vibration of the molecules.

RELATIONS BETWEEN CLIMATE AND CROPS.[1]

THE weather exerts a tacit, though relentless, tyranny over the labour and the thought of the agriculturist. The probable influences of the present and prospective weather upon the growing crops are seldom absent from his mind. But science teaches that climate is rhythmic, not capricious. Laplace has shown that the mean temperature of the mass of the earth cannot have changed in any appreciable measure during the entire period of astronomical calculation, and that while the planetary movements remain as at present no such change can occur. "Astronomical permanency," he says, "implies an absolute fixedness of the quantity of heat for the mass of the earth." And the sun's heat is the leading element of climate; all other conditions depend in the long run upon that. Hence, the sun's heat being constant, all the changes we observe are periodic as regards the astronomical units, the day and the year; and non-periodic in all other cases, the averages returning always to a line of absolute permanency.

Climate is the average of seasonal atmospheric conditions, and as corn is an annual plant, these fluctuating seasonal factors must affect its growth. The crop season is in fact the climatic unit with respect to this cereal. No season exactly repeats itself; there are perturbations within relatively narrow limits; the plant strives perpetually to adjust itself to perfect correspondence with its environment. As this environment—that is, climate and food supply—vibrates now one way, now another, about a fixed mean, the consequent variations of the plant will be compensatory, and so there should be no final permanent modification of the plant in a given locality.

Aside from its direct control of the amount and quality of the crop, climatic variations, by vitiating experience, impede agricultural progress. This fact is most apparent in the agricultural history of a new country, where experience acquired in one district is in many cases not only useless, but positively pernicious, when applied to a distant district. In the United States millions of dollars have been lost through the efforts of new settlers to learn by experience the climatic peculiarities of their adopted home. It is the province of agricultural science to teach how to profit by the experience that has been so dearly bought in the past.

Agricultural climatology considers the relations between the meteorological elements measured in terms of plant development. As intimate as these relations are known to be, and as interesting and promising a field as their study is known to offer, it is rather surprising that no adequate organised effort has yet been expended in this direction. But we are coming to see that the very fact of this intimate reciprocal dependence may be turned to advantage, and that by methods of correlation the facts of each science may be made to illumine the other.

The laws of biological and of meteorological phenomena separately considered are extremely subtle and complex, and any attempt to study them in their manifold reciprocal relations is sufficiently difficult to deter any but the best equipped and most zealous students. This difficulty of properly interpreting the separate effects upon vegetation of heat, light, moisture, and the gases of the atmosphere is enhanced by the fact that a change in one meteorological condition ordinarily disturbs all the other elements. For example, rain is accompanied by cloudiness, decrease in light and heat, and, it may be, by an increase of warmth in the soil, if the rain be a warm one.

Extended and elaborate meteorological observations have been conducted in the United States and in Europe, but instruments measure only detached elements of climate; plants alone record its composite or cumulative effects. Hence, the insistence on the part of leading agricultural investigators that climate should be studied in terms of plant life. Such study is termed phenology, and while it has led to some valuable generalisations, the fragmentary character of the data vitiates many of its conclusions. It appears that in the past phenologists have given the element of heat undue, if not almost exclusive, weight. It is becoming more and more evident that the real function and value of light have been neglected and undervalued. A fundamental theory which has been held by botanists for more than a century is, briefly, that a certain life event takes place in any species whenever that species has been exposed to a certain sum total of heat, which is called the physiological constant or thermal constant. In harmony with this theory, Blodgett, in his "Climatology of the United States," says with regard to corn that its period of growth is precisely proportional to the abruptness of the temperature curve; that its unusual elasticity of constitution admits it to all regions where the temperature reaches a certain point, however brief the duration of this warm period may be. He defines the extreme northern limits of Indian corn as coincident with the isotherm of 67° for July, though a somewhat higher mean for one summer month is required, and he attributes the increase of productiveness at the north mainly to "the hasty growth, the excess of heat while it lasts, and the hastened ripening period." The seemingly insignificant item of a deficiency of two degrees on the mean of a single summer month practically excludes this crop from the British Isles, where it is grown, when grown at all, only as a forage crop, seldom maturing any grain. This statement of the subject has been for fifty years the popular and the current theory. Temperature being the most easily measured of the solar manifestations, it has quite naturally been regarded as the dominant one. Then, too, the rudimentary state of climatology made necessary such a simplification as is afforded by the consideration of heat alone.

The trend of recent opinion is summarised by Prof. Abbe in his extensive manuscript report of June 1891, on the "Relations of Climate and Crops," where, after reviewing the investigations of Tisserand, he concludes:—

That the temperature of the air has apparently little to do, in and of itself, with the duration of time from sowing to ripening, but that this depends principally on the sunshine. The temperature of the air controls the chemical composition of the seed, but the effective sunshine seems to be the productive climatic element; it furnishes the total energy at the disposal of the plant, but it is also the one least studied and understood.

Prof. Sturtevant, of New York, from tests with 128 varieties, concludes that "actinism has an influence scarcely secondary to temperature." So it would seem wise in the light of recent study to attribute much of the hostility of a climate like that of England to the greater degree of cloudiness, and the congeniality of the climate of the Western States to the habitually clear skies of summer.

In discussing climate and corn it will be convenient to treat their relations first historically and then analytically; a cursory glance at the more evident accumulated results of climatic modification and limitation will prepare the way for an outline of the individual factors that constitute environment and the principles that govern the life of the plant.

The original home of corn or maize is now quite certainly known to have been in Central Mexico, and hence it is the only one of our cereals that is indigenous to the New World. It has been so long and so thoroughly domesticated that no truly wild varieties are known. In geographical range and elasticity of habit it probably surpasses every other cultivated plant. From its original tropical home it has spread to the temperate as well as the tropical regions of the world. Introduced into

[1] Abridged from a paper by Mr. H. B. Wren in the U.S. *Monthly Weather Review.*

Europe soon after the conquest of Mexico, it finds a genial home only in the warm valleys of the south and central portions of that continent; it is extensively grown in Africa, and in India it thrives everywhere throughout the hill country; it appears to flourish as well in the temperate as the tropical regions, and at altitudes of from sea-level to 7000 feet or more. Corn is, however, as it has always been and will undoubtedly remain, a distinctive and characteristic American product. It is cultivated from Canada to Patagonia, over 7000 miles of latitude. It has been known to ripen as far north as 63°, and has been found a profitable crop in latitude 51° north. In response to the multifarious conditions which this great range imposes, countless varieties have been developed, there being more than 200 in the United States alone.

The effects of climate on maize may be appropriately classified as immediate, intermediate, and incidental. Prof. Storer has tersely said that the prime object of agriculture is to collect for purposes of human aggrandisement as much as may be possible of the energy that comes from the sun in form of light and heat. Now the working capacity of sunshine is, according to Kelvin, one horse-power for every seven square feet of surface. Measured by the standards of mechanics, how inefficient and wasteful an engine is our agriculture at its best. The atmosphere is directly the source of 95 per cent. of the material in the total plant and of 98 per cent. of the matter in the grain of corn. The plant is an elaborate machine that absorbs and transforms energy, utilising solar radiation to digest carbon dioxide in the leaves and to combine into vegetable organs and tissues the gases of the air with the elements supplied by the soil. When we remember that the amount of energy available, the food supply, and, consequently, the amount of matter stored, all depend directly upon meteorological conditions, we realise how overwhelming is the influence of climate.

A grain of maize once matured is as inert as a pebble until heat and moisture are applied; then a sprout and a root appear, each for a separate function, the one for absorbing ethereal waves, the other for absorbing water. In addition to heat and moisture, oxygen is absolutely essential to germination, as well as to all subsequent growth. The importance of moisture will be appreciated when we recall that water performs at least four distinct offices: first, directly as a food, being united in the leaves with carbon to form the carbohydrates; second, as a solvent for the nutritive matters in the soil; third, as the vehicle which transports the soluble food through the roots and stems to the leaves; and, finally, as a cooling device, since, through evaporation, water largely controls the temperature of the plant. The "free water of vegetation," as it is called, or the water of the juices, comprises from 70 to 90 per cent. of corn in the fodder stage, while the "combined water of vegetation," or the water that remains after the plant is air-dried, is 12 per cent. in a kernel of corn.

The immediate effects of climate will be better understood by glancing first at its intermediate effects through the medium of the soil and through the food-supply. Climate originates soil and all the capacities of the earth for tillage, and it is at the same time more than soil or tillage. For in a truly "good year" the worst tilled soil returns a more bountiful harvest than it is possible with all our industry to extort from the best tilled soil in a "bad year." The oasis differs from the desert only in the item of water supply, and a given climate does not result primarily from the nature of the earth's surface; on the contrary, that surface is determined almost wholly by climate. The agencies that produce, and are producing arable areas from the seemingly impervious and indurate rocks, must continue their action perennially if the soil is to maintain itself. Indeed, the reverse metamorphosis is constantly at work. The greater part of the known rock formations were once in the form of soil, and chemical, physical, and even vital forces are continually engaged in the work of rock making, as well as rock breaking, so that an important office of agriculture is to oppose this cyclic law of nature, and to counteract the retrogressive tendency from soil to rock.

Primarily, the soil is a reservoir of moisture and plant food; but hardly secondary is its office as a vast laboratory, wherein during the warmer seasons countless complex chemical agencies and numberless microscopic organisms operate unceasingly. Indeed, the relations of climate to the plant through the medium of the soil are so intimate and vital that no just idea of their importance can be given here. These relations may be classed as physical, chemical and biological.

The physical texture of the soil determines its conductivity for heat and its content of water and air, both of which in proper proportions are essential to the chemical and biological functions. Moreover, the water content, through its power to absorb, transform, and conserve radiant energy, controls the temperature of the soil. Finally, soil temperature is far more effective than the temperature of the air. Heat is well known to accelerate diffusion, solution, osmotic action, and evaporation. Now these physical processes are precisely those that perform the chief, almost the entire work involved in plant nutrition and growth. Hence, a high soil temperature is essential not only for the life of the plant itself, but also for the ventilation and the life of the soil, a healthy soil being very appropriately called a living mass. On an average 40 per cent. of the radiant energy incident on the soil is absorbed, conducted downward, and stored in the form of heat, 60 per cent. being lost to the soil by reflection, radiation and evaporation.

Oxygen is as indispensable to the chemical life of the soil as it is to animal life. Both oxygen and nitrogen are essential to the biological processes, and both the chemical and biological activities in the soil are as indispensable to the crop as are sunshine and showers.

The importance of right proportions of water and air in the soil is further shown by the fact that the process of decay, whereby organic material is turned into humus and made available to the plant, cannot go on without an abundant supply of oxygen. A soil that contains too much water contains too little air. The ferments thrive best at a temperature of 85° to 95°, and when the soil contains from one-half to one-third the amount of water required for saturation. The ultimate source of the nitrogen found in vegetable matter is the air, and plants are unable directly to utilise it in a free state. The bacteria, which are chiefly concerned in maintaining the available supply of nitrogen in the soil, are able to work only during the warm seasons, and their activity depends directly on the temperature of the soil, being a maximum at 98°. On the other hand, light is inimical to the life and activity of these soil bacteria, a fact that may have some bearing on the rapid growth of corn during hot nights, inasmuch as the work of the micro-organisms in feeding the roots is then facilitated. That corn germinates best at the high temperature of 98° to 100° is, undoubtedly, due to its tropical origin. For Prof. Davenport shows that the attunement of plants to environment as regards temperature has its origin, not in processes of selection, but in the modifications of protoplasm by temperature itself.

Granted that the soil is porous enough and dry enough to admit the air readily, ventilation is facilitated by the unequal heating of night and day, and by non-periodic temperature changes as well. As the air within the soil is heated it expands, and some of it is forced downward to the deeper layers; when it cools it contracts, and free air is drawn into the soil. The same effect is produced by barometric changes; the passage of areas of high and low pressure has been found to influence the flow of water from drains to the extent of 15 per cent., thus showing an unexpected movement of air in the soil. The corn belt lies entirely within the region of maximum frequency and intensity of barometric oscillations in the United States. Strong, and particularly gusty winds, by a measurable aspiratory action, have also a significant influence on soil breathing.

Having seen how heat, light, moisture, and the supply of gases operate to control the supply of those ingredients that are furnished by the soil and that constitute in the main the ash of the plant, we return now to the immediate effect of these elements on the vital processes and assimilation.

While light is indispensable to the assimilation of carbon dioxide, it undoubtedly exerts a directly retarding influence on growth proper, or cell multiplication, but the beneficial effects of the higher temperature that accompanies daylight more than counteract this. Sachs showed that for many plants, when kept at a uniform temperature, the rate of growth gradually increases during the night and is a maximum shortly after daybreak. This effect of light is opposed to the effect of the diurnal temperature; heat and light increase transpiration, which means a loss of water, and hence less growth. This sensitiveness and response of protoplasm to light is the result of the chemical changes wrought therein by the light.

By osmotic action the root hairs imbibe the liquid food that surrounds them; capillary and osmotic actions carry this supply to every part of the plant, to the tip of every blade, which is not only bathed in air, but has its microscopic interstices permeated with it. Here, in the leaf cells, the carbon dioxide of the air, which is practically an invariable quantity, comes in contact with the water that has been brought from the roots. Here, too, the energy of the ether waves, which we call light, but which the vegetable cell recognises only as force, or a mode of motion, causes the carbon dioxide to part with some of its oxygen in exchange for some of the hydrogen contained in the water. Thus, there is formed within the cell a substance composed of carbon, hydrogen, and oxygen, the exact molecular structure of which is not known; in this process some of the oxygen is freed and thrown off by transpiration. By the introduction of the molecule of carbon dioxide into the cell the equilibrium in the atmosphere of that gas is disturbed and another molecule diffuses into its place; for this gas exists and behaves as if it were the only gas present in the space under consideration, the same law being true for each of the gaseous elements whose mixture constitutes what is called the atmosphere. The consumption of carbon dioxide tends constantly to produce a vacuum in the carbon dioxide atmosphere, and the law of diffusion as constantly tends to maintain the supply. If molecules of hydrogen are withdrawn from the fluid contents of the cell, instantly osmosis and diffusion tend to replace them; the same is true of the solid particles in solution. Assimilation within the cells of the leaves perpetually destroys the equilibrium of osmotic pressure, hence this pressure creates a constant flow toward the seat of demand. Evaporation from the leaves, which is proportional to temperature and is accelerated by winds, as is the supply of carbon dioxide, operates in the same direction, viz. to destroy the equilibrium in the leaf cells and channels, and consequently the tiny streams from the rootlets are hastened onward with their precious stores of food. Cold not only stiffens the sap and retards its flow, but also slackens molecular motion and hinders the chemical reorganisation of the elements. The process of evaporation proper is, however, almost independent of the processes of nutrition, and is rather a "necessary evil." The most rapid growth frequently occurs under precisely those conditions that make evaporation least rapid.

The quantity of water that passes through the plant and is transpired and evaporated is enormous. The average is about three hundred parts of water to one of dry matter. According to experiments by Prof. King of the Wisconsin Experiment Station, dent corn used three hundred and ten tons and flint corn two hundred and thirty-four tons of water for each ton of dry matter produced. This same experimenter supplied growing corn with water as fast as it could be used to advantage, and found that the crop consumed during its season of growth water equivalent to a rainfall of 34·3 inches, and yielded more than four times as bountifully as a very large crop grown under the best natural conditions of rainfall in Wisconsin. And he concludes that "large as this movement of water is, it is seldom great enough to enable a moderately fertile field to produce its largest crops." And these tests in Wisconsin merely confirm a conclusion that is becoming quite general, and is prompting the advocacy of irrigation even in the humid regions. Moreover, the quantity of water producing a given result increases with the fertility of the soil, and, according to Wollny, the soil moisture produces its maximum results only when the plants are grown in the strongest light. The value of a given quantity of rainfall for the crop increases as the number of rains, and what has been called the useful remainder of rainfall is only 20 per cent. of the total amount, percolation and evaporation accounting for 80 per cent. Percolation is a fertile source of loss of the valuable soil nitrates, especially in the wet fall and winter seasons, when the corn-field is bare and a large proportion of the water escapes downward. Rain, like snow, is the "poor man's fertiliser," bringing down, per acre, in the course of a year, at Rothamsted, England, twenty-four pounds of salt, four and a half pounds of nitrogen, eighteen pounds of sulphuric acid, and much carbon dioxide, which is a valuable solvent.

Some of the less important incidental relations of climate and corn, such as electricity, winds, frost, insect enemies, and diseases remain to be mentioned. Electricity artificially applied to the roots by charging the soil, and to the leaves by means of the electric light, have both repeatedly been found to stimulate the growth, and, in some instances, greatly to accelerate it. Recent experiments show that when green leaves are exposed to direct sunlight there is developed a difference of electrical potential between the illumined and the shaded surfaces, amounting in some cases to ·02 volt, but the bearing of this fact upon assimilation is not well known. Atmospheric electricity is a fertile source of ozone, or condensed oxygen, which is particularly active in the production of nitric acid. Electricity stimulates protoplasm, the ultimate vital principle, and may determine the character of its activities, but under natural conditions this element is believed to have but slight influence.

Seasonal characteristics have practical connection, too, with the insect pests and diseases of corn. Not only during the crop season are these pests largely at the mercy of the elements, but fitful winters are sure to prove destructive to them, for during the bright, warm days eggs are hatched, chrysalides matured, and insects lured from their retreats, only to be caught and destroyed by the sudden cold waves. The fungus diseases, such as rust and smut, are carried by winds, and are favoured by wet seasons, dews, and moist atmosphere.

So sensitive is the plant to the changes of climate that even the ordinary seasonal irregularities have a strong influence; the general disposition acquired by the seed in a single dry or wet, warm or cold, early or late, season prepares it by virtue of that experience to become the best seed for planting in anticipation of another such season as that in which the seed was matured. This tendency is illustrated by the well-known fact that dwarfed varieties of corn from northern latitudes, when cultivated to the southward, mature earlier, are hardier, and more prolific than the native varieties. A corollary of great practical promise is that in a region habitually or frequently dry, corn raised in the driest years should be preserved for seed, as likely to be far better than any that may be brought from a distance. Hence the common, if not universal, practice of using seed grown in the preceding year is strongly condemned. By always utilising seed that has been raised in the driest years one may hope speedily to develop varieties whose vegetating period will be so short that the crop will rarely be injured by the hot winds of July or August. And a similar rule would apply for any desired disposition we may seek to impress upon the seed.

In the light of these facts it is suggested that irrigation may come to be used as a temporary device to promote the evolution of new varieties that can be cultivated without irrigation. On the other hand, recent careful work in France has demonstrated that when the plants are forced to their maximum yield by irrigation the seed thereby suffers a marked deterioration, and that for continued maximum results the seed must be raised on dry soil.

Climate being inviolable and inexorable, what hope is there that the agriculturist shall be emancipated from the tyranny of frost and drought? Clearly, he must attain this by work on the soil and on the plant. By utilising vast stores of energy in the form of fuel man banishes the rigours of winter, thus creating artificial conditions of shelter and heat, by aid of which he has supplemented the process of acclimatisation. Thus, also, must he co-operate with Nature in behalf of the plant: he must combat her malignant aspects by intelligent selection; by scientific methods of culture he must supplement her beneficent efforts on behalf of the human race.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. J. W. BULLERWELL, assistant lecturer at the Durham College of Science, Newcastle-on-Tyne, has been appointed assistant lecturer in mathematics at the Hartley College, Southampton.

FOLLOWING the usual custom, addresses will be given at many of the metropolitan and provincial medical schools, at the opening of the new session early in October. At St. George's Hospital an introductory address will be given by Dr. P. W. Latham, of Cambridge. The first meeting of the Physical Society of Guy's Hospital will be held on October 5, in the new physiological theatre, when Sir Samuel Wilks, F.R.S., will preside. At St. Mary's Hospital the session will begin on October 1 with an introductory lecture by Dr. William Hill. The session at the Middlesex Hospital will also begin on October 1, when Mr. T. H. Kellock will give an introductory address. The session of the Faculty of Medicine of University College will be opened with an introductory lecture by Prof. J. Risien Russell. The session of the London (Royal Free Hospital) School of Medicine for Women will be opened with an introductory lecture by Dr. F. W. Andrews. The winter session at Charing Cross Hospital will open on Wednesday, October 2, when an introductory address will be delivered by Prof. J. W. Taylor. At the inauguration of the sixtieth session of the School of Pharmacy, the Hanbury gold medal will be presented, and the inaugural address will be delivered by Dr. Arthur P. Luff. At the Royal Veterinary College the sessional course of instruction will be opened with an introductory address delivered by Dr. E. M. Crookshank. The winter session at Yorkshire College, Leeds, will open on October 1, when an introductory address will be delivered by Sir W. S. Church. At University College, Sheffield, the session will be opened with an introductory address by Sir Thomas Barlow.

SEVERAL prospectuses and calendars of technical institutions, showing the courses of work for the session just commencing, have been received. The London Polytechnics give prominence to the announcement that are recognised as qualified institutions from which students who have matriculated in the University of London may be presented for the new engineering degrees of the University. Courses of work suitable for such students have been arranged, and they should be the means of extending the knowledge of the science of engineering. In the prospectus of the Battersea Polytechnic, trade students are rightly warned against only attending classes connected with their occupations. It is pointed out that the principles of science must be studied, as well as technical subjects, if a thoroughly sound knowledge is desired. Without a working acquaintance with mathematics, mensuration and geometry it is almost impossible to make any real and useful advance in science and technology. This ought to be clearly understood, and it is worth while to consider whether students should not be compelled to give evidence of such knowledge before being permitted to join technological classes, where their presence is often a hindrance to progress. The calendar of the Northampton Institute, Clerkenwell, also contains much good advice as to the choice of studies, and the objects to be borne in mind. Among the noteworthy characteristics of the work of this Institute are the electrochemical laboratory, which has been equipped in a very complete manner, the attention given to horological engineering, and the department of optical and scientific instruments. But while there is evidence of progress in the work of our polytechnics and technical schools, there is still much to be done before they reach the standard of similar institutes in Germany and the United States, such, for instance, as the Rose Polytechnic Institute, Terre Haute, Indiana, the new calendar of which is before us. Each of the courses in this Institute occupies four years of three terms each, and no undergraduate student is permitted to elect any special or partial course. All students must take full work in one of the courses, and each member of the senior class must present a thesis recording an independent investigation at the close of the year. The value of this educational policy is indicated by the high positions which the alumni of the Institute occupy as professional engineers.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 20.—"On the Resistance and Electromotive Forces of the Electric Arc." By W. Duddell, Whitworth Scholar. Communicated by Prof. W. E. Ayrton, F.R.S.

The author considers that the new facts given in the paper assist in formulating a consistent explanation of the resistance and back E.M.F. of the arc. The values found for the resistance of the vapour column and for the contacts between it and the electrodes offer no serious difficulties. The greater part of the two E.M.F.'s are considered as being most probably due to thermo-electric forces, and experiments in support of this view are described, in which it was found possible to obtain a P.D. of 0·6 volt by unequally heating two *solid* carbon electrodes with a blow-pipe flame, the voltmeter indicating that the hotter carbon was positive to the cooler. By using *cored* carbons and adding potassium salts, this P.D. was increased to 1·5 *volts.* It is pointed out that the differences of temperature existing in the arc must be many times as great as those which it is possible to produce with the blow-pipe, as the cooler electrode must be red-hot, or else it does not seem to make contact with the surrounding flame.

On the Resistance of an Electrolyte.—In measuring the resistance of an electrolyte by the Kohlrausch method, it is often assumed that the errors due to polarisation are avoided if the frequency of the alternating or interrupted current used is as high as a few hundred periods per second. Experiments made to test this point lead to the conclusion that unless other methods are adopted to eliminate the effects of polarisation, *it must not be assumed that the use of alternating currents of ordinary frequencies of a few hundred periods per second eliminates the possibility of errors due to polarisation.*

PARIS.

Academy of Sciences, September 2.—M. Bouquet de la Grye in the chair.—On the application of the equations of Lagrange to electrodynamic and electromagnetic phenomena, by M. E. Sarrau. The application of the method of Lagrange to electrical phenomena leads to results which are naturally in accord with the principle of energy, since this principle is only one form of the theorem of kinetic energy, and this is a consequence of the general equations. But for this agreement to exist it appears to be necessary to admit that the internal energy of a system of currents and magnets is purely kinetic, no part of it being potential.—On the quadratic transformation of Abelian functions, by M. Georges Humbert.—Observations of the Encke comet made at the Observatory of Algiers, by MM. Rambaud and Sy. Observations of the magnitude, apparent positions of comparison stars, and apparent positions of the comet taken between the 9th and 18th of August.—On the continuous deformation of surfaces, by M. G. Tzitzéica.—Outline of a general theory of mechanisms, by M. G. Koenigs.—On the equilibrium of elastic bodies, by M. R. Liouville.—Evaluation of the resistance of steel to traction deduced from the resistance to shearing, by M. Ch. Fremont. The curve for resistance to shearing per square millimetre plotted as ordinates against the resistance to extension as abscissæ is a straight line.—On the first stages of development of some Polycystidea, by MM. L. Leger and O. Duboscq. Observations on three groups of Polycystidea, *Actinocephalides, Dactylophorides,* and *Clepsidrinides,* show that the typical evolution allows no intracellular stage. They differ in this respect from the intestinal Monocystidia, as has been shown by Caullery and Mesnil.—On scissiparity in the Hydroides, by M. Armand Billard.—On the appearance of the white rot (*Charrinia Diplodiella*) in Algeria, by MM. J. D. Catta and A. Maige.—On a case of sexual determinism produced by mixed grafting, by M. A. Jurie.

CONTENTS.

THURSDAY, SEPTEMBER 19, 1901.

WIRELESS TELEGRAPHY.

Drahtlose Telegraphie durch Wasser und Luft. Based on Lectures delivered in the Winter of 1900 by Prof. Dr. Ferdinand Braun, Director of the Physical Institute of the University of Strassburg. Pp. 68. (Leipzig: Veit and Co., 1901.) Price M. 2.

THE rapid development of wireless telegraphy which has taken place in the last few years has called forth many articles in the scientific and technical papers, but as yet but few single treatises or text-books. Prof. Braun is known as an experimenter in this branch of electrical science, and the pamphlet under notice treats of the subject from a more or less popular point of view and also gives a short sketch of some of Prof. Braun's own experiments. The first chapter is an interesting historical *résumé* of the endeavours to signal over a distance without the use of intervening wires. It is interesting to observe that the discovery that the earth could serve as a return conductor for the ordinary telegraph first led up to the thought that the other wire could also be replaced by the earth or air or other medium. In one point we think Prof. Braun's remarks are hardly in agreement with the latest of our ideas—we mean in his description of the Becquerel and radium rays as being of the nature of light and electric waves. This is hardly in accordance with the corpuscle theory, which approaches, as near as it is possible at present, to an explanation of these phenomena. The chapter after this historical introduction deals with the author's own experiments on hydrotelegraphy. The guiding idea of the work was to use the property of an alternating current, with sufficiently high frequency, to flow only on the surface of a conductor. If, now, such a current be led in and out at two points of a sheet of water, the current, instead of penetrating deep down, will tend to spread itself out upon the surface of the water, and by connecting a receiving circuit at any two other points, messages can be passed between the two stations. This method of working differs in principle from that of Rathenau and Strecker, who used stationary currents. With this arrangement, if the receiver be connected to two points lying on an equipotential line, *i.e.* a line drawn at right angles to the current lines, no messages can be received. With Braun's arrangement this is different, due to the fact that the equipotential lines continually change. With experiments made at Cuxhaven, signals could be sent for a distance of three kilometres, it being proved that the effect was neither transmitted through the air nor was it an induction effect similar to Preece's experiments. All the results agree fully with the enunciated principle.

It is difficult, however, to think, in spite of the author's hopes, that this system will ever be of much practical importance in view of the development of the Marconi system.

The second chapter gives an account of Prof. Braun's experiments on wireless telegraphy proper. The results of these experiments have been published in various papers and have also received attention in this Journal. The transmitter arrangement mostly used by Braun is that of inductive excitement. Tested against the Marconi arrangement, much better results were obtained, and Prof. Braun is of opinion that this is the best of all the devised arrangements up to date. It must be remembered, however, that Marconi has considerably improved his apparatus quite recently and has now obtained results better than those given here.

The next chapter is on "tuned telegraphy"; it is pointed out that an un- or very little damped vibration is the first condition for good syntony. This principle is now universally recognised.

In his final remarks, Prof. Braun is of opinion that the hopes that have been entertained that wireless telegraphy will ever displace the ordinary wire telegraphy are an illusion, a conclusion which is now becoming general. The spheres of usefulness of wireless telegraphy are, however, even without this, very great, and in the near future will greatly develop.

As a short, clearly written contribution to the literature of the subject, the book is worth reading. C. C. G.

OUR BOOK SHELF.

Geometrical Exercises from Nixon's "Euclid Revised," with Solutions. By Alexander Larmor, M.A. Pp. vi + 170. (Oxford: Clarendon Press, 1901.)

THIS is a collection of 823 examples illustrating the various propositions of Euclid's six books, as well as many other domains of the geometry of the right line and circle, such as maxima and minima, collinearity and concurrency, centres of similitude, coaxal circles, inversion, harmonic ranges, poles and polars, and the modern geometry of the triangle. It will thus be seen that everything of importance in the subject is dealt with. Hints are given for the solution of all the more easy questions, while fully worked out solutions are given for the more advanced. The work is therefore one of very great value both for the student and for the teacher. All the classical problems and theorems in the subject are associated with the names of their discoverers—Ptolemy, Euler, Pascal, Brianchon, Simson, &c.—and each receives ample illustration and application. This is one of the many good features of the work. Mr. Larmor is quite right in maintaining that the student of geometry should be provided with a copious and varied collection of exercises, and with an opportunity for consulting the solution of a problem or theorem in which he has failed while his interest in it is still fresh. Such an opportunity is afforded by this excellent representative collection. Doubtless much assistance in this way is derivable from the work of the late Prof. Townsend; but his book is, perhaps, too elaborate and unmanageable for the average student, on whose attention many other branches of mathematics now make large demands.

Histoire du Ciel. Par Clémence Royer. Pp. 246. (Paris: Librairie C. Reinwald, 1901). Price 2 fcs. 50.

WHILE correctly stating a considerable number of facts, this little book, which forms the first volume of a "Petite Encyclopédie Scientifique du XX^e Siècle," by no means represents the state of astronomical science at the present time. The earlier chapters recount the history of astronomy to the time of Newton, but afterwards the bulk of the matter is descriptive and speculative. So little acquainted is the author with recent work, that among many strange ideas expounded we find the suggestion that the rings of Saturn are not composed of multitudes of small bodies but of coherent masses of ice. The illustrations are very poor, and the book should be avoided by those desiring a trustworthy guide to current opinions.

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THE DENVER MEETING OF THE AMERICAN ASSOCIATION.

THE American Association held its fiftieth annual meeting at Denver, Colorado, during the week beginning August 24, under the presidency of Prof. Charles S. Minot, of Harvard University. This is the first time that the Association has met west of the banks of the Mississippi River, and the meeting consequently marks a somewhat important epoch in the development of science in America. The central and western States have occupied somewhat the same position towards the Atlantic seaboard as this part of the country held in relation to Europe until about twenty-five years ago. Until the development of the eastern universities, the scientific men of the United States were largely trained abroad and looked chiefly to Great Britain and the Continent for their scientific models. Up to the present time the central and western States—engaged in subduing Nature on a scale hitherto unattempted—have depended on the Atlantic States for their education, their science and their literature. The development of the universities in the central and western States during the past ten years has, however, been remarkable. Of the forty universities in the world having more than 2000 students, seven—Michigan, Chicago, North-Western, Wisconsin, Minnesota, Illinois and California—are situated in this region; and these institutions are not mere schools, but universities and centres for the advancement of science, rivalling Leipzig or Cambridge in their standards and in their productiveness. The time has obviously come when men of science in the west can meet on equal terms their colleagues in the east, and this event was signalised by the meeting of the Association at Denver, midway between the Atlantic and Pacific coasts. The meeting, though not so largely attended as is usual further to the east—the members from either the Atlantic or Pacific coasts had 2000 miles to travel—was successful both on its social and scientific sides. Hospitality is the virtue of a new country, and the people of Denver were prepared to entertain the Association by social functions and excursions in a way that is not usual in the United States.

Before the ten sections into which the Association is divided some two hundred and twenty papers were presented, and while perhaps none of them was of such importance as to deserve special notice, they represented on the whole a high level of scientific work. The address of the retiring president, Prof. R. S. Woodward, of Columbia University, appears in the present issue of NATURE. Public addresses on topics suited to the place of meeting were made by Prof. C. R. Van Hise, who discussed the nature of ore deposits, and by Mr. Gifford Pinchot, chief of the Bureau of Forestry, who considered questions of irrigation and forestration.

Owing to a change in procedure by which the chairmen of sections give their addresses when retiring from office, there were this year only five such addresses. Before the section of chemistry, Prof. J. H. Long, of North-Western University, took as the subject of his address the development of the teaching of chemistry in the United States; before the section of mechanical science and engineering, Mr. John A. Brashear, acting Chancellor of the Western University of Pennsylvania, described the plans, drawn up at Mr. Carnegie's request, for a great technical college at Pittsburg which would call for an endowment of from 10,000,000 to 20,000,000 dollars; before the section of zoology, Prof. Charles B. Davenport, of the University of Chicago, discussed the quantitative study of variation—a subject to which he has devoted special attention, being associated with Profs. Pearson and Weldon in the newly established journal *Biometrika*; before the section of anthropology, Mr. Amos W. Butler, of the Indiana State Board of Charities, described the methods used under his direction for the care of the feeble minded in the State of Indiana, with scientific deductions on heredity and the like; before the section of social and economic science, Prof. C. M. Woodward, of Washington University, St. Louis, and a leader in the introduction of manual training into the schools of the United States, discussed what he called "The change of front in education." A new section of the Association, devoted to physiology and experimental medicine, was organised and will hold its first meeting for the reading of papers next year.

The business transacted at the meeting was of unusual importance. The first report was made in regard to the plan of sending the weekly journal, *Science*, free of charge to all members of the Association. It is apparently working well, for this and the efficiency of the present permanent secretary, Dr. L. O. Howard, has resulted in an addition of about 1500 permanent new members, chiefly scientific men, in the course of the year. The American Association is becoming a centre for national scientific societies, and hereafter the societies devoted to the special sciences will be represented on the council of the Association. Efforts have recently been made to secure for America a convocation week for the meetings of scientific and learned societies, and the leading universities have agreed to set aside for this purpose the week in which January 1 falls. The American Association will hold a meeting in mid-winter at Washington at the beginning of the year 1903, when there will be a congress of at least twenty scientific societies. The next meeting of the Association will, however, be at Pittsburg at the beginning of next July. It will be presided over by the eminent astronomer, Dr. Asaph Hall.

ADDRESS BY PROF. R. S. WOODWARD, PRESIDENT OF THE ASSOCIATION.

The Progress of Science.

A CONSTITUTIONAL provision of our Association stipulates that "It shall be the duty of the President to give an address at a General Session of the Association at the meeting following that over which he presided." Happily for those of us who must in turn fulfil this duty, the scientific foresight of our predecessors set no metes and bounds with respect to the subject-matter or the mode of treatment of the theme that might be chosen for such an address. So far, therefore, as constitutional requirements are concerned, a retiring president finds himself clothed for the time being with a degree of liberty which might be regarded as dangerous were it not for an unwritten rule that one may not hope to enjoy such liberty more than once. But time and place, nevertheless, as well as the painful personal limitations of any specialist, impose some rather formidable restrictions. One may not tax lightly, even, in a summer evening, the patience of his audience for more than an academic hour, the length of which in most cases is less than sixty minutes. One must confine himself to generalities, which, though scientifically hazardous, serve as a basis for semi-popular thought; and one must exclude technical details, which, though scientifically essential, tend only to obscure semi-popular presentation. Courtesy, also, to those who are at once our hosts and our guests requires that, so far as possible, one should substitute the vernacular for the "jargon of science," and draw his figures of speech chiefly from the broad domain of every-day life rather than from the special, though rapidly widening, fields of scientific activity.

Between this nominally unlimited freedom on the one hand, and these actually narrow restrictions on the other, I have chosen to invite your attention for the hour to a summary view of the salient features of scientific progress, with special reference to its effects on the masses, rather than on the individuals, of mankind. We all know, at least in a general way, what such progress is. We are assured almost daily by the public Press and by popular consent that the present is not only an age of scientific progress but that it is preeminently the age of scientific progress. And with respect to the future of scientific achievement, the consensus of expert opinion is cheerfully hopeful and the consensus of public opinion is extremely optimistic. Indeed, to borrow the language sometimes used by the rulers of nations, it may be said that the realm of science is now at peace with all foreign parts of the world and in a state of the happiest domestic prosperity.

But times have not been always thus pleasant and promising for science. As we look backward over the history of scientific progress it is seen that our realm has been taxed often to the utmost in defence of its autonomy, and that the present state of domestic felicity, bordering on tranquillity, has been preceded often by states of domestic discord bordering on dissolution. And, as we look forward into the new century before us, we may well inquire whether science has vanquished its foreign enemies and settled its domestic disputes for good and all, or whether future conquests can be made only by a similarly wasteful outlay of energy to that which has accompanied the advances of the past. Especially may we fitly inquire on an occasion like the present what are the types of mind and the methods of procedure which make for the progress, and what are the types of mind and the methods of procedure which make for the regress, of science. And I venture to think that we may inquire also with profit, in some prominent instances, under what circumstances in the past science has waxed or waned, as the case may be, in its slow rise from the myths and mysticism of earlier eras to the law and order of the present day. For it is a maxim of common parlance, too well justified, alas! by experience, that history repeats itself; or, to state the fact less gently, that the blunders and errors of one age are repeated with little variation in the succeeding age. This maxim is strikingly illustrated by the history of science, and it has been especially deeply impressed upon us—burnt in, one might say—by the scientific events of our own times. Have we not learned, however, some lasting lessons in the hard school of experience, and may we not transmit to our successors along with the established facts and principles of science the almost equally well established ways and means for the advancement of science? Will it be possible for society to repeat in the twentieth century the appalling intellectual blunders of the nineteenth century, or have we entered on a new era in which, whatever other obstacles are pending, we may expect man to stand notably less in his own light as regards science than ever before? To a consideration of these and allied questions I beg your indulgence, even though I may pass over ground well known to most of you, and encroach, perhaps, here and there, on prominences in fields controversial; for it is only by discussion and rediscussion of such questions that we come at last, even among ourselves in scientific societies, to the unity of opinion and the unity of purpose which lead from ideas to their fruitful applications.

From the earliest historic times certainly, if not from the dawn of primitive humanity, down to the present day, the problem of the universe has been the most attractive and the most illusive subject of the attention of thinking men. All systems of philosophy, religion and science are alike in having the solution of this problem for their ultimate object. Many such systems and sub-systems have arisen, flourished and vanished, only to be succeeded by others in the seemingly Sisyphean task. Gradually, however, in the lapse of ages there have accumulated some elements of knowledge which give inklings of partial solutions; though it would appear that the best current opinion of philosophy, religion and science would again agree in the conclusion that we are yet immeasurably distant from a complete solution. Almost equally attractive and interesting, and far more instructive, as it appears to me, in our own time is the contemplation of the ways in which man has attacked this perennial riddle. It is, indeed, coming to be more and more important for science to know how primitive, barbarous, and civilised man has visualised the conditions of, and reached his conclusions with respect to, this problem of the centuries; for it is only by means of a lively knowledge of the baseless hypotheses and the fruitless methods of our predecessors that we can hope to prevent history from repeating itself unfavourably.

Looking back over the interval of two to three thousand years that connects us by more or less authentic records with our distinguished ancestors, we are at once struck by the admirable confidence they had acquired in their ability to solve this grand problem. Not less admirable, also, for their ingenuity and for the earnestness with which they were advanced, are the hypotheses and the arguments by which men satisfied themselves of the security of their tenets and theories. Roughly speaking, it would appear that the science of the universe received its initial impulse from earliest man in the hypothesis that the world is composed of two parts, the first and most important part being, in fact, if not always so held ostensibly, himself, and the other part being the aggregate of whatever else was left over. Though dimly perceived and of little account in its effects, this is, apparently, the working hypothesis of many men in the civilised society of to-day. But the magnitude of the latter part and its inexorable relations to man seem to have led him speedily to the adoption of a second hypothesis, namely, that the latter part, or world external to himself, is also the abode of sentient beings, some of a lower and some of a higher order than man, their *rôle* tending on the whole to make his sojourn on this planet tolerable and his exit from it creditable, while yet wielding at times a more or less despotic influence over him.

How the details of these hypotheses have been worked out is a matter of something like history for a few nationalities, and is a matter absorbing the attention of anthropologists, archæologists, and ethnologists as it concerns races in general. Without going far afield in these profoundly interesting and instructive details, it may suffice for the present purposes to cite two facts which seem to furnish the key to a substantially correct interpretation of subsequent developments.

The first of these is that the early dualistic and antithetical visualisation of the problem in question has persisted with wonderful tenacity down to the present day. The accessible and familiar was set over against the inaccessible and unfamiliar; or, what we now call the natural, though intimately related to, was more or less opposed to the supernatural, the latter being, in fact, under the uncertain sway of, and the former subject to the arbitrary jurisdiction of, good and evil spirits.

The second fact is that man thus early devised for the investigation of this problem three distinct methods, which have likewise persisted with equal tenacity, though with varying fortunes, down to the present day. The first of these is what is known as the *a priori* method. It reasons from subjective postulates to objective results. It requires, in its purity, neither observation nor experiment on the external world. It often goes so far, indeed, as to adopt conclusions and leave the assignment of the reasons for them to a subsequent study. The second is known as the historico-critical method. It depends, in its purity, on tradition, history, direct human testimony and verbal congruity. It does not require an appeal to Nature except as manifested in man. It limits observation and experiment to human affairs. The third is the method of science. It begins, in its elements, with observation and experiment. Its earlier applications were limited mostly to material things. In its subsequent expansion it has gained a footing in nearly every field of thought. Its prime characteristic is the insistence on objective verification of its results.

All of these methods have been used more or less by all thinking men. But for the purposes of ready classification it may be said that the first has been used chiefly by dogmatists, including especially the founders and advocates of all fixed creeds from the atheistic and pantheistic to the theistic and humanistic; the second has been used chiefly by humanists, including historians, publicists, jurists and men of letters; and the third has been used chiefly by men of science, including astronomers, mathematicians, physicists, naturalists and, more recently, the group of investigators falling under the comprehensive head of anthropologists. The first and the third methods are frequently found to be mutually antithetical, if not mutually exclusive. The second occupies middle ground. Together they are here set down in the order of their apparent early development and in the order of their popularly esteemed importance during all historic time previous to, if not including, this first year of the twentieth century.

No summary view of the progress of science, it seems to me, can be made intelligible except by a clear realisation of these two facts, which may be briefly referred to as man's conception of the universe and his means of investigating it. What, then, in the light of these facts, has been the sequel? The full answer to this question is an old and a long story, now a matter of minute and exhaustive history as regards the past twenty centuries. I have no desire to recall the dramatic events involved in the rise of science from the Alexandrian epoch to the present day. All these events are trite enough to men of science. A mere reference to them is a sufficient suggestion of the existence of a family skeleton. But, setting aside the human element as much as possible, it may not be out of place or time to state what general conclusions appear to stand out clearly in that sequel. These are our tangible heritage, and upon them we should fix our attention.

In the first place, the progress of science has been steadily opposed to, and as steadily opposed by, the adherents of man's primitive concepts of the universe. The domain of the natural has constantly widened and the domain of the supernatural has constantly narrowed. So far, at any rate, as evil spirits are concerned, they have been completely cast out from the realm of science. The arch fiend and the lesser princes of darkness are no longer useful even as an hypothesis. We have reached—if I may again use the cautious language of diplomacy—a satisfactory *modus vivendi* if we have not attained permanent peace in all our foreign relations. Enlightened man has come to see that his highest duty is to cooperate with Nature, that he may expect to get on very well if he heeds her advice, and that he may expect to fare very ill if he disregards it.

Secondly, it appears to have been demonstrated that neither the *a priori* method of the dogmatists nor the historico-critical method of the humanists is alone adequate for the attainment of definite knowledge of either the internal or the external world, or of their relations to one another. In fact, it has been shown over and over again that man cannot trust his unaided senses even in the investigation of the simplest and most obvious material phenomena. There is an ever present need of a correction for personal equation. Left to himself, the *a priori* reasoner weaves from the tangled skein of thought webs so well tied by logical knots that there is no escape for the imprisoned mind except by the rude process applied to cobwebs. And in the serenity of his repose behind the fortress of "liberal culture" the reactionary humanist will prepare apologies for errors and patch up compromises between traditional beliefs and sound learning with such consummate literary skill that even "the good demon of doubt" is almost persuaded that if knowledge did not come to an end long ago it will soon reach its limit. In short, we have learned, or ought to have learned, from ample experience, that in the search for definite, verifiable knowledge we should beware of the investigator whose equipment consists of a bundle of traditions and dogmas along with formal logic and a facile pen; for we may be sure that he will be more deeply concerned with the question of the safety than with the question of the soundness of scientific doctrines.

Thirdly, it has been demonstrated equally clearly and far more cogently that the sort of knowledge we call scientific, knowledge which has in it the characteristics of immanence and permanence, is founded on observation and experiment. The rise and growth of every science illustrate this fact. Even pure mathematics, commonly held to be the *a priori* science par excellence, and sometimes called "the science of necessary conclusions," is no exception to the rule. Those who would found mathematics on a higher plane have apparently forgotten to consider the contents of the mathematician's waste-basket. The slow and painful steps by which astronomy has grown out of astrology and chemistry out of alchemy; and the faltering, tedious, and generally hotly contested advances of geology and biology, have been made secure only by the remorseless disregard which observational and experimental evidence has shown for the foregone conclusions of the dogmatists and the literary opinions of the humanists. Thus it has been proved by the rough logic of facts and events that the rude processes of "trial and error," processes which many philosophers and some men of science still affect to despise, are the most effective means yet devised by man for the discovery of truth and for the eradication of error.

These facts are so well known to most of you, so much a matter of ingrained experience, that the categorical mention of them here may seem like a rehearsal of truisms. But it is one of the paradoxes of human development that errors which have been completely dislodged from the minds of the few may still linger persistently in the minds of the many, and that the misleading hypotheses and the dead theories of one age may be resuscitated again and again in succeeding ages. Thus, to cite one of the simplest examples, it doubtless appeared clear to the Alexandrian school that the flat, four-cornered earth of contemporary myths would speedily give way to the revelations of geometry and astronomy. How inadequate such revelations proved to be at that time is one of the most startling disclosures in all history. The "Divine School of Alexandria" passed into oblivion. The myth of a flat and four-cornered earth was crystallised into a dogma strong enough to bear the burden of men's souls by Cosmas Indicopleustes in the sixth century; it was supported with still more invincible arguments by Martin Luther in the sixteenth century; and it was revived and maintained with not less truly admirable logic, as such, by John Hampden and John Jasper in the last decades of the nineteenth century. To cite examples from contemporary history showing how difficult it is for the human mind to get above its primitive conceptions, one needs only to refer to the daily Press. During the past two months, in fact, the newspapers have related how men, women and children, many of them suffering from loathsome if not contagious diseases, have visited a veritable middle-age shrine in the city of New York, strong in the hoary superstition that kissing an alleged relic of St. Anne would remove their afflictions. During the same interval a railway circular has been distributed explaining how tourists may witness the Moki snake-dance, that weird ceremony by which the Pueblo Indian seeks to secure rain in his desert; and a similar public, and officially approved, ceremony has been observed in the heat-stricken State of Missouri.

Such epochs and episodes of regression as these must be taken into account in making up an estimate of scientific progress. They show us that the slow movement upward in the evolution of man which gives an algebraic sum of a few steps forward per century is not inconsistent with many steps backward. Or, to state the case in another way, the rate of scientific advance is to be measured not so much by the positions gained and held by individuals, as by the positions attained and realised by the masses of our race. The average position of civilised man now is probably below the mean of the positions attained by the naturalist Huxley and the statesman Gladstone, or below the mean of the positions attained by the physicist von Helmholtz and His Holiness the Pope. When measured in this manner, the rate of progress in the past twenty centuries is not altogether flattering or encouraging to us, especially in view of the possibility that some of the recently developed sciences may suffer relapses similar to those which so long eclipsed geography and astronomy.

It must be confessed, therefore, when we look backward over the events of the past two thousand years, and when we consider the scientific contents of the mind of the average denizen of this planet, that it is not wholly rational to entertain millennial anticipations of progress in the immediate future. The fact that some of the prime discoveries of science have so recently appeared to many earnest thinkers to threaten the very foundations of society is one which should not be overlooked in these confident times of prosperity. And the equally important fact that entire innocence with respect to the elements of science and dense ignorance with respect to its methods have not been hitherto incompatible with justly esteemed eminence in the divine, the statesman, the jurist, and the man of letters, is one which should be reckoned with in making up any forecast. It may be seriously doubted, indeed, whether the progress of the individual is not essentially limited by the progress of the race.

But this obverse and darker side of the picture which confronts us from the past has its reverse and brighter side; and I am constrained to believe that the present status of science and the general enlightenment of humanity justify ardent hopefulness if not sanguine optimism with respect to the future of scientific achievement. The reasons for this hopefulness are numerous; some of them arising out of the commercial and political conditions of the world, and others arising out of the conditions of science itself.

Perhaps the most important of all these reasons is found in the general enlargement of ideas which has come, and is coming, with the extension of trade and commerce to the uttermost parts of the earth. We are no longer citizens of this or that country, simply. Whether we wish it or not we are citizens of the world, with increased opportunities and with increased duties. We may not approve—few men of science would approve, I think—that sort of "expansion" which works "benevolent assimilation" of inferior races by means of a bible in one hand and a gun in the other; but nothing can help so much, it seems to me, to remove the stumbling blocks in the way of the progress of science as actual contact with the manners, the customs, the relations, and the resulting questions for thought, now thrust upon all civilised nations by the events of the day. That sort of competition which is the life of trade, that sort of rivalry which is the stimulus to national effort, and that sort of cooperation which is essential for mutual protection, all make for the cosmopolitan dissemination of scientific truth and for the appreciation of scientific investigation. I would not disparage the elevated aspirations and the noble efforts of the evangelists and the humanists who seek to raise the lower to the plane of the higher elements of our race; but it is now plain as a matter of fact, however repulsive it may seem to some of our inherited opinions, that the railway, the steamship, the telegraph, and the daily Press will do more to illumine the dark places of the earth than all the apostles of creeds and all the messengers of the gospel of "sweetness and light."

A question of profound significance growing out of the extension of commercial relations in our time is what may be called the question of international health. An outbreak of cholera in Hamburg, the prevalence of yellow fever in Havana, or an epidemic of bubonic plague in India is no longer a matter of local import, as nations with which we are well acquainted have learned recently in an expensive manner. The management of this great international question calls for the application of the most advanced scientific knowledge and for the most intricate scientific investigation. Large sums of money must be devoted to this work, and many heroic lives will be lost, doubtless, in its execution; but it is now evident, as a mere matter of international political economy, that the cost of sound sanitation will be trifling in comparison with the cost of no sanitation; while further careful study of the natural history of diseases promises practical immunity from many of them at no distant day. International associations of all kinds must aid greatly also in the promotion of progress. Many such organisations have, indeed, already undertaken scientific projects with the highest success. Comparison and criticism of methods and results not only lead rapidly and effectively to improvements and advances, but they lead also to a whole-hearted recognition of good work which puts the fraternalism of men of science on a plane far above the level of the amenities of merely diplomatic life.

When we turn to the general status of science itself, there is seen to be equal justification for hopefulness founded on an abundance of favourable conditions. The methods of science may be said to have gained a footing of respectability in almost every department of thought, where, a half century ago, or even twenty years ago, their entry was either barred out or stoutly opposed. The "Conflict between Religion and Science"—more precisely called the conflict between theology and science—which disturbed so many eminent though timid minds, including not a few men of science, a quarter of a century ago, has now been transferred almost wholly to the field of the theological contestants; and science may safely leave them to determine the issue, since it is evidently coming by means of scientific methods. The grave fears entertained a few decades ago by distinguished theologians and publicists as to the stability of the social fabric under the stress put upon it by the rising tide of scientific ideas have not been realised. And, on the other hand, the grave doubts entertained by distinguished men of science a few decades ago as to the permeability and ready response of modern society to that influx of new ideas have likewise not been realised. It is true that we sometimes read of theological tests being applied to teachers of biology, and hear, occasionally, of an earnest search for a good Methodist or a good Presbyterian mathematician; but such cases may be left for settlement out of court by means of the arbitration of our sense of humour.

It seems not unlikely, also, that there may persist, for a long time to come, a more or less guerilla "warfare of science" with our friends the dogmatists and the humanists. Some consider this conflict to be, in the nature of things, irrepressible. But I think we may hope, if we may not confidently expect, that the collisions of the future will occur more manifestly than they have in the past in accordance with the law of the conservation of energy; so that the heat evolved may reappear as potential energy in the warmth of a kindly reasonableness on both sides, rather than suffer degradation to the level of cosmic frigidity.

Great questions, also, of education, of economic, industrial and social conditions, and of legal and political relations are now demanding all the light which science can bring to bear upon them. Though tardily perceived, it is now admitted, generally, that science must not only participate in the development of these questions but that it alone can point the way to the solutions of many of them. But there is no halting ground here. Science must likewise enter and explore the domain of manners and morals; and these, though already largely modified unconsciously, must now be modified consciously to a still greater extent by the advance of science. Only within quite recent times have we come to realise an approximation to the real meaning of the trite saying that the true study of man is man. So long as the most favoured individuals of his race, accordance with the hypothesis of the first centuries, looked upon him as a fallen, if not a doomed, resident of an abandoned reservation, there could be roused little enthusiasm with respect to his present condition; all thought was concentrated on his future prospects. How incomparably different does he appear to the anthropologist and to the psychologist at the beginning of the twentieth century! In the light of evolution he is seen to be a part of, and not apart from, the rest of the universe. The transcendent interest of this later view of man lies in the fact that he can not only investigate the other parts of the universe, but that he can, by means of the same methods, investigate himself.

I would be the last to look upon science as furnishing a speedy or a complete panacea for the sins and sorrows of mankind; the destiny of our race is entangled in a cosmic process whose working is thus far only dimly outlined to us; but it is nevertheless clear that there are available to us immense opportunities for the betterment of man's estate. For example, to mention only one of the lines along which improvement is plainly practicable, what is to hinder an indefinite mitigation, if not a definite extinction, of the ravages of such dread diseases as consumption and typhoid fever? Or what, we may ask, is to hinder the application to New York, Philadelphia and Chicago of as effective health regulations as those now applied to Havana? Nothing, apparently, except vested interests and general apathy. We read, not many years ago, that a city of about one million inhabitants had, during one year, more than six thousand cases of typhoid fever. The cost to the city of a single case may be estimated as not less, on the average, than one thousand dollars, making an aggregate cost to that city, for one year, of more than six millions of dollars. Such a waste of financial resources ought to appeal to vested interests and general apathy even if they cannot be moved by any higher motives. Thanks to the penetration of the enlightenment of our times, distinct advances have already been made in the line of effective domestic and public sanitation; but the good work accomplished is infinitesimal in comparison with that which can be, and ought to be, done. It is along this, and along allied lines of social and industrial economy, that we should look, I think, for the alleviation of the miseries of mankind. No amount of contemplation of the beatitudes, human or divine, will prevent men from drinking contaminated water or milk; and no fear of future punishments, which may be in the meantime atoned for, will much deter men from wasting their substance in riotous living. The moral certainty of speedy and inexorable earthly annihilation is alone adequate to bring man into conformity with the cosmic rules and regulations of the drama of life.

And, finally, we must reckon amongst the most important of the conditions favourable to the progress of science the unexampled activity in our times of the scientific spirit as manifested in the work of all kinds of organisations from the semi-religious Chautauquan assemblies up to those technical societies whose programmes are Greek to all the world beside. Literature, linguistics, history, economics, law and theology are now permeated by the scientific spirit, if not animated by the scientific method. Curiously enough, also, the terminology, the figures of speech and the points of view of science are now quite common in realms of thought hitherto held somewhat scornfully above the plane of materialistic phenomena. Tyndall's Belfast address, which, twenty-seven years ago, was generally anathematised, is now quoted with approval by some of the successors of those who bitterly denounced him and all his kind. Thus the mere lapse of time is working great changes and smoothing out grave differences of opinion in favour of the progress of science in all the neighbouring provinces with which we have been able hitherto to maintain only rather strained diplomatic relations.

Still more immediately important to us are the evidences of progress manifested in recent years by this Association and by its affiliated societies. Our parent organisation, though half a century old, is still young as regards the extent in time of the functions it has undertaken to perform. It has accomplished a great work; but in the vigour and enthusiasm of its youth a far greater work is easily attainable. Exactly how these functions are to be developed no man can foresee. We may learn, however, in this, as in other lines of research, by methods with which we are well acquainted, namely, by the methods of carefully planned and patiently executed observation and experiment. The field for energetic and painstaking effort is wider and more attractive than ever before. Science is now truly cosmopolitan; it can be limited by no close corporations, and no domain of scientific investigation can be advantageously fenced off, either in time or in place, from the rest. While every active worker of this or of any affiliated society is, in a sense, a specialist, there are occasions when he should unite with his colleagues for the promotion of science as a whole. The results of the specialists need to be popularised and to be disseminated among the people at large. The advance of knowledge to be effective with the masses of our race must be sustained on its merits by a popular verdict. To bring the diverse scientific activities of the American continent into harmony for common needs; to secure cooperation for common purposes; and to disseminate the results of scientific investigation among our fellow-men, are not less, but rather much more, than in the past the privilege and the duty of the American Association for the Advancement of Science.

Viewed, then, in its broader aspects, the progress of science is involved in the general progress of our race; and those who are interested in promoting the former should be equally earnest in securing the latter. However much we may be absorbed in the details of our specialities, when we stop to think of science in its entirety, we are led, in the last analysis, back to the problem of problems—the meaning of the universe. All men "gifted with the sad endowment of a contemplative mind" must recur again and again to this riddle of the centuries. We are, so to speak, whatever our prepossessions, all sailing in the same boat on an unknown sea for a destination at best not fully determined. Some there are who have, or think they have, the Pole Star always in sight. Others, though less confident of their bearings, are willing to assume nothing short of second place in the conduct of the ship. Others, still less confident of their bearings, are disposed to depend chiefly on their knowledge of the compass and on their skill in dead reckoning. We of the latter class may not impugn the motives or doubt the sincerity of the first two classes. We would find it difficult, probably, to dispense with their company in so long a journey after becoming so well acquainted with them; for among them we may each recall not a few of those rarer individuals of the genus homo called angels on earth. But it must be said in all truth, to resume the figure, that they have neither improved much the means of transportation nor perfected much the art of navigation. They have been sufficiently occupied, perhaps, in allaying the fears of the timid and in restraining the follies of the mutinous. Other types of mind and other modes of thought than theirs have been essential to work out the improvements which separate the earlier from the later nautical equipments of men; such improvements, for example, as mark the distinction between the dug-out of our lately acknowledged relatives, the Moros and the Tagalogs, from the Atlantic-liner of to-day. At any rate, we are confronted by the fact that man's conceptions of the universe have undergone slow but certain enlargement. His early anthropocentric and anthropomorphic views have been replaced, in so far as he has attained measurable advancement, by views that will bear tests of astronomy and anthropology. He has learned, slowly and painfully, after repeated failures and many steps backward, to distinguish, in some regions of thought, the real and the permanent from the fanciful and fleeting phenomena of which he forms a part. His pursuit of knowledge, in so far as it has led him to certainty, has been chiefly a discipline of disillusionment. He has arrived at the truth not so much by the genius of direct discovery as by the laborious process of the elimination of error. Hence he who has learned wisdom from experience must look out on the problem of the universe at the beginning of the twentieth century with far less confidence in his ability to speedily solve it, and with far less exaggerated notions of his own importance in the grand aggregate of Nature, than man entertained at the beginning of our era. But no devotee of science finds humiliation in this departure from the primitive concepts of humanity. On the contrary, he has learned that this apparent humiliation is the real source of enlightenment and encouragement; for notwithstanding the relative minuteness of the speck of cosmic dust on which we reside, and notwithstanding the relative incompetency of the mind to discover our exact relations to the rest of the universe, it has yet been possible to measure that minuteness and to determine that incompetency.

These, in brief, are the elements of positive knowledge at which we have arrived through the long course of unconscious, or only half-conscious, experience of mankind. All lines of investigation converge towards or diverge from these elements. It is along such lines that progress has been attained in the past, and it is along the same lines that we may expect progress to proceed in the future.

THE GLASGOW MEETING OF THE BRITISH ASSOCIATION.

THE seventy-first annual meeting of the British Association came to an end yesterday. For the purposes of the meeting the entire accommodation of the College Buildings was placed at the disposal of the Association by the University authorities, while for the opening meeting the St. Andrew's Hall was granted by the Corporation. Between 2000 and 3000 persons attended at the St. Andrew's Hall to hear the opening address of the president, Prof. A. W. Rücker, F.R.S. The retiring president, Sir William Turner, F.R.S., took the chair and introduced his successor, who afterwards delivered the presidential address, which was printed in last week's NATURE; and on Thursday morning the work of the sections commenced. Reports of the proceedings of the sections will appear in these columns as in previous years.

Melancholy interest was given to the meeting by the expressions of sympathy sent to the United States by the Association in connection with the assassination of the late President M'Kinley. At the first meeting of the General Committee, it was decided, upon the proposition of Sir Michael Foster, seconded by Sir John Evans, that the following telegram be sent on behalf of the Association:—"That the British Association for the Advancement of Science, assembled at Glasgow, desires to make known to President M'Kinley its feeling of horror at the attempt upon his life, its sympathy with him in his suffering, and its earnest hope for his speedy and complete restoration to health." A reply expressing thanks for the sympathy was received from the late President's secretary on Thursday evening.

The news of the death of President M'Kinley became known on Saturday morning, when only two sections of the Association were sitting. At the close of the meeting of one of these sections—Educational Science—Sir John Gorst, the president, referred in touching terms to the profound grief which British people share with those of the United States at the terrible event that had occurred. The members present stood while expression was being given to their feelings by the president, and the following resolution, moved by him and seconded by Sir Philip Magnus, was adopted in solemn silence:—

"That this section of the British Association has heard with profound grief of the death of President M'Kinley, and records its deep sympathy with the family of the late President and the people of the United States of America in their domestic and national bereavement."

Many distinguished members of the Association were present at the opening by Lord Lister, on September 12, of the new Anatomical Department of Glasgow University, comprising an extensive laboratory, museum, &c. The building has been presented to the University by the trustees of the late Mr. J. B. Thomson, and Lord Lister, in opening this important addition to the resources of the University, remarked that it comprised "as fine a laboratory as existed in the world, and at the same time a capacious, commodious, and beautiful anatomical museum adjoining it." Prof. Cleland has presented to the University his large collection of anatomical specimens, and this, with the specimens collected by his predecessors and placed in the museum, makes the anatomical department a place where work can be carried on under excellent conditions.

In considering the general success of the meeting, it must be borne in mind that many citizens of Glasgow had their scientific interests almost exhausted before the meeting began, by the International Engineering Congress which immediately preceded it. It is well understood locally that the many congresses and celebrations which have been held in Glasgow since last June supply the reason for the comparatively small attendance at this year's meeting of the Association. The first Glasgow meeting in 1855 was attended by 2133 members and associates, and the total number present at the second meeting in 1876 was 2774. This year, however, the attendance has scarcely reached 1900. But the many claims which the City and Universities authorities have had upon their hospitality did not diminish the liberality of the welcome extended to the Association. Throughout the meeting the social as well as the scientific pleasures of the members have been attended to in the most generous manner. For instance, the reception given by the Corporation in the magnificent City Chambers will be remembered by everyone who attended it as one of the most brilliant yet given in honour of the Association.

Next year's meeting will be held at Belfast, and will begin on September 10, 1902. Prof. James Dewar, F.R.S., will be the president. The vice-presidents for the meeting will be the Marquis of Dufferin and Ava, the Lord-Lieutenant of County Down, the Marquis of Londonderry, Sir Francis Macnaughten, the Lord-Lieutenant of County Antrim, the Right Honourable the Earl of Shaftesbury, the Right Honourable the Earl of Rosse, the Lord Mayor of Belfast, the president of Queen's College, Belfast; Rev. Dr. Salmon, the president of Trinity College, Belfast; Sir William Quartus Ewart, the Right Honourable Thomas Sinclair, and Prof. E. Ray Lankester, F.R.S.

The meeting in 1903 will be held at Southport.

The following is a synopsis of grants of money appropriated to scientific purposes by the General Committee at the meeting on Monday:—

Mathematics and Physics.	
*Rayleigh, Lord—Electrical Standards	£40
*Judd, Prof. J. W.—Seismological Observations	35
Shaw, Mr. W. N.—Investigation of the Upper Atmosphere by means of Kites...	75
Preece, Sir W.—Magnetic Observations at Falmouth ...	80
Chemistry.	
*Hartley, Prof. W. N.—Relation between Absorption Spectra and Constitution of Organic Substances ...	20
*Roscoe, Sir H. E.—Wave-length Tables	5
Roberts-Austen, Sir Wm. C.—Properties of Metals and Alloys affected by dissolved Gases	40
Geology.	
*Marr, Mr. J. E.—Erratic Blocks (£6 in hand)	—
*Geikie, Prof. J.—Photographs of Geological Interest ...	5
*Marr, Mr. J. E.—Life-zones in British Carboniferous Rocks	10
*Watts, Prof. W. W.—Underground Water of North-West Yorkshire (balance in hand)	—
*Scharff, Dr.—Exploration of Irish Caves	45
*Woodward, Dr. H.—Type Specimens (balance in hand)	—
Zoology.	
*Herdman, Prof. W. A.—Table at the Zoological Station, Naples	100
*Garstang, Mr. W.—Table at the Biological Laboratory, Plymouth (balance £8 5s. in hand)	—
*Woodward, Dr. H.—Index Generum et Specierum Animalium...	100
*Newton, Prof. A.—Migration of Birds	15
*Sedgwick, Mr. A.—Structure of Coral Reefs of Indian Region	50
Murray, Sir John.—Compound Ascidians of the Clyde Area	25
Geography.	
*Keltie, Dr. J. Scott—Terrestrial Surface Waves ...	£15
Economic Science and Statistics.	
*Brabrook, Mr. E. W.—Legislation regulating Women's Labour	30
Mechanical Science.	
*Preece, Sir W. H.—Small Screw Gauge (balance in hand and)	20
*Binnie, Sir A.—Resistance of Road Vehicles to Traction	50
Anthropology.	
*Evans, Mr. A. J.—Silchester Excavation	5
*Penhallow, Prof. D. P.—Ethnological Survey of Canada	15
*Garson, Dr. J. G.—Age of Stone Circles...	30
*Read, Mr. C. H.—Photographs of Anthropological Interest (balance in hand)	—
*Tylor, Prof. E. B.—Anthropological Teaching	3
*Evans, Sir John.—Exploration in Crete	100
Macalister, Prof. A.—Anthropometric Investigations of Native Egyptian Soldiers	15
Rhys, Prof. J.—Excavations on the Roman Site at Gelligaer	5
Physiology.	
McKendrick, Prof. J. G.—Changes in Hæmoglobin ...	15
McKendrick, Prof. J. G.—Work of Mammalian Heart under influence of Drugs...	20
Botany.	
Farmer, Prof. J. B.—Investigations of the Cyanophyceæ	10
Marshall Ward, Prof.—The Respiration of Plants ...	15
Educational Science.	
Armstrong, Dr. H. E.—Reciprocal Influence of Universities and Schools	5
—— Conditions of Health essential to carrying on Work in Schools...	2
Corresponding Societies.	
*Whitaker, Mr. W.—Preparation of Report	15
	£1015

* Re-appointed.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. PERCY F. FRANKLAND, PH.D., M.SC., F.R.S., PRESIDENT OF THE SECTION.

The Position of British Chemistry at the Dawn of the Twentieth Century.

Two circumstances unite in rendering this year especially appropriate for the survey and valuation of all departments of British life and organisation—the dawn of a new century, the close of the Victorian era. It is a moment when not only the nation as a whole, but every group of persons drawn together by whatever bond, and indeed each individual for himself, must involuntarily ask the question, Are we progressing or receding, or are we standing still? Upon us, then, who are bound together by the common interest which we have in that science to which this Section is devoted there forces itself the question, What is the position of British Chemistry at the present moment, how does this present bear comparison with the past, and what are the prospects for the future?

To bring before you some considerations with respect to the answer which should be given to this question, or rather series of questions, will be my endeavour in responding to the honour which has been conferred on me of inaugurating the work of our Section at this meeting of the Association.

It is with no light heart that I undertake this task, for there are present here to-day those whose much longer experience and far more intimate connection with the progress of our science render it presumption on my part to address them on this subject at all.

It is well known that the history of British Chemistry, as, indeed, that of British science in general, is a very remarkable one: it is almost entirely made up of achievements which are the result of private initiative; and the persons who have taken part in the making of this history have, with some notable exceptions, not been servants of the State, and have thus differed from the makers of scientific history in almost every other country in the world. Thus the opportunities for the investigations which are recorded in the *Transactions* of our Chemical Society have, for the most part, not been provided out of the public purse, but by private individuals or by institutions which have been created by private benefaction.

This unique condition of things is well illustrated by taking up a volume of the Chemical Society's *Journal* and glancing at the table of contents.

Thus in the volume for 1881, taken at random, we find that, out of the seventy-five original communications which it contains, only thirteen emanate from Government laboratories, whilst what will surely not a little surprise the scientific historian of some centuries hence is the circumstance that there are only four communications from the so-called "ancient seats of learning" of the United Kingdom, no fewer than three of which are by one and the same investigator. Again, most noteworthy is the fact that as many as five contributions are from distinguished amateurs. We have been told, on what many persons regard as high authority, that England is suffering from amateurism in all departments of life; and however true this may be as a general proposition, the amateurs of British science, like Gladstone, Schunck and Perkin amongst living chemists, are assuredly some of the most valued possessions of this country.

On looking back a quarter of a century into the past it is at once apparent how greatly during that short period of time—less than a generation of men—have the opportunities for higher chemical training been extended and multiplied in our midst. I think I shall not be far wrong in saying that until twenty-five years ago practically the only public laboratories in which the higher study of chemistry could be pursued were those of the Royal College of Chemistry, the Royal Institution, of University and King's Colleges, London, the University laboratories of England, Scotland and Ireland, as well as those of the Queen's Colleges and of the Royal College of Science in the sister island; to which must be added the laboratories of two institutions of a somewhat different type, viz. Owens College, Manchester, and Anderson's College, in this great city of the north. It is the rapid multiplication of institutions of the Owens College type that constitutes probably the most important feature in the higher intellectual development of the population of this country during the past quarter of a century; indeed, it may very possibly be found in the future that this constitutes the most striking landmark in the history of British intellectual progress during recent times. A glance at the following table will show the remarkably rapid growth of these institutions during the last quarter of the nineteenth century:—

Opening of University Colleges.

University College, London		1828
King's College, London		1831
Owens College, Manchester		1851
Durham College of Science, Newcastle		1871
University College, Aberystwyth		1872
Yorkshire College, Leeds		1875
University College, Bristol		1876
University College, Nottingham		1877
Firth College, Sheffield		1879
Mason College, Birmingham		1880
University College, Liverpool		1882
University College, Dundee		1882
University College, Cardiff		1883
University College, Bangor		1884
Finsbury Technical College	City Guilds	1883
Central Institution	City Guilds	1885

Thus the opening of the greater number of these institutions falls within the decade 1875–1884.

The benefits arising from the creation of these numerous institutions have not, however, been by any means limited to those persons who have actually taken advantage of their instruction, for their existence has stimulated the establishment of many other institutions, some of which, like the two colleges founded and maintained out of the resources of the City and Guilds of London, although more limited in their scope, afford equal or even greater opportunities for higher scientific training in the particular branches which are represented.

The foundation of these University Colleges and of other institutions for higher education by private initiative, and without a particle of assistance from the public exchequer, is quite in keeping with the history of a country in which it is recognised that the Government does not lead, but only follows where it is drawn or propelled.

It would certainly be anticipated that such a large addition to the machinery for higher scientific training as is represented by the creation of these numerous local colleges during the past twenty-five years would have had a marked influence on the output of scientific discovery in this country. We will endeavour to ascertain whether such a result is discernible in the case of chemical science. Turning to the *Transactions* of the Chemical Society, I have compiled the following table in the hope of obtaining some information on this point:—

Original Communications in the Transactions of the Chemical Society.

1849	29	1862	81	1875	49	1888	75
1850	33	1863	51	1876	54	1889	71
1851	33	1864	54	1877	58	1890	71
1852	28	1865	49	1878	61	1891	95
1853	22	1866	47	1879	84	1892	90
1854	23	1867	49	1880	75	1893	104
1855	30	1868	47	1881	75	1894	83
1856	14	1869	37	1882	65	1895	116
1857	14	1870	38	1883	63	1896	117
1858	30	1871	28	1884	57	1897	114
1859	21	1872	32	1885	85	1898	102
1860	25	1873	46	1886	85	1899	120
1861	32	1874	49	1887	88	1900	127

The activity displayed in chemical research, as measured by the number of original communications to the Chemical Society, is, however, best followed by a consideration of the aggregate number of papers contributed during the three following decades:—

Decade	Total Number of Papers in *Transactions* of Chemical Society
1855–1864	352
1865–1874	422
1875–1884	641
1885–1894	847

From these figures it is manifest, even without the application of any of those mathematical processes in which modern chemists are becoming so expert, that the most remarkable increase in the number of original investigations is indeed coincident with that decade, 1875–1884, in which the great majority of the institutions to which I have referred began to throw their prismatic rays of knowledge on many thousands who until then were sitting in shadow or even in darkness.

That these new institutions should have so immediately borne fruit in the manner I have indicated cannot fail to be surprising to those who have been associated with the early years of almost any of these colleges, for when a faithful record of the experiences of their first professors is written the extraordinary obstacles which these pioneers had to encounter, and which in so many cases they successfully overcame, should afford material for a most remarkable, instructive, and even amusing volume. The worthy founders and their executors or trustees appear in general to have supposed that it was only necessary to provide a spacious building, and then appoint a staff of professors who were to do the rest, whilst the necessity of funds for annual upkeep, for libraries, and for assistants was almost overlooked.

It has indeed been learnt by bitter experience that the cost of efficiently maintaining institutions of this most ambitious character is enormously greater than was supposed in this country twenty-five years ago, and that founding a college, far from resembling the inauguration of a remunerative business, is very like entrance into the bond of matrimony, with its attendant annually increasing demand upon the pecuniary resources of the paterfamilias.

It would not indeed be surprising if some of these modern colleges had been long debarred from contributing directly to the progress of scientific investigation in this country, for this was often assuredly considered amongst the least of the many arduous duties imposed upon their first professors. Ascertained capacity to enrich science was in some cases almost a presumptive disqualification for their chairs, or at any rate took a back seat beside enthusiasm for evening classes and faith in the efficacy of that mysterious panacea "technical instruction." It is indeed lamentable to think of the valuable years of productive work lost to the country through so much of the energy of these early professors having been sacrificed to these veritable fetishes of our would-be educational reformers.

Notwithstanding the unfavourable conditions under which most of these university colleges had in the first instance to carry on work, it was not long before they showed that they were to become, even during the tenure of office of their first professors, important centres for the prosecution of research—at least as far as chemical science was concerned. Owens College had indeed already led the way in this matter before the period with which I am more especially concerned to-day, for there the first professor of chemistry had pursued his memorable investigations on the organo-metallic compounds, and had, within the first five years after the foundation of the College, enunciated that generalisation which was subsequently extended into the *law of valency*; whilst under his successors, Sir Henry Roscoe, Schorlemmer, Harold Dixon, and Perkin, jun., the Owens College has become perhaps the largest and best equipped school of scientific chemistry in the British Islands.

From the Yorkshire College, Leeds, opened in 1875, there proceeded immediately in rapid succession that whole series of careful investigations relating more especially to specific volume and other physical constants which we associate with its first chemical professor, Thorpe, and his coadjutors.

In the west of England, where the University College of Bristol was opened in 1876, the chair of chemistry was first occupied by the man who has so recently once more proved to the world that there are discoveries made in these islands which for striking originality and independence are unsurpassed and hardly equalled elsewhere. It was during his tenure of the chair at Bristol that Ramsay, assisted by his able fellow-worker and successor Sidney Young, carried out those important and most laborious investigations on vapour pressure and the thermal properties of liquids which not only displayed his extraordinary fertility and resource as an experimenter, but also revealed that exceptional freshness of mind which has enabled him to discern new methods of attacking problems that have already engaged the attention of many able men before him.

Turning from the west of England to the Midlands, where, in 1880, there was founded, through the private munificence of the late Sir Josiah Mason, a college bearing his name, which, before even attaining its majority, was transformed at the psychological moment, as by the wand of the magician, into the University of Birmingham. The first professor of chemistry at the Mason College, my distinguished predecessor, Tilden, soon made opportunity there to continue those early researches on the terpenes with which his name will always be associated. We find him also further elaborating the important uses as a reagent of nitrosyl chloride, which he had a number of years previously shown how to prepare in a state of purity, and which has played a somewhat similar part in the exploration of the terpene hydrocarbons that phenylhydrazine has done in the elucidation of the sugar-group. In addition to these investigations we find Tilden at Birmingham also turning his attention to some of the phenomena attending the solution of salts. The younger men attached to the Mason College also found there the opportunity of enriching chemical science with the results of notable investigations; for do we not all remember Thomas Turner's valuable contributions to our knowledge of the influence of chemical composition on the physical and mechanical properties of cast iron? Whilst early amongst those detailed investigations on the phenomena of solution, which in recent years have had such far-reaching effects on the development of our science, must be mentioned Dr. Nicol's experiments on the volume changes attending the mixture of salt solutions, and on the molecular volume, the boiling point, and expansion of such solutions.

In the bleak north-east of our island, at Dundee, where a college was founded in 1882 with an extremely handsome endowment by members of the Baxter family, the first professor of chemistry, Carnelley, fired by that restless and almost perfervid energy which doubtless hastened his untimely end, soon found opportunity to interrogate Nature in various directions, notwithstanding the arduous teaching duties which his insatiable love of work had imposed upon himself. Thus, already in 1884, we find him, in his quest for material which should throw light on the periodic relationship of the elements, continuing his laborious work on melting points and publishing those two ponderous quarto volumes in which every known melting point was recorded, and forming truly one of the most remarkable compilations ever attempted in our science. Of these volumes he might indeed have said, "Exegi monumentum ære perennius," for they will assuredly prove a record of the boundless energy which characterised the man, more imperishable even than the memorial tablet erected by his admiring students and friends in the entrance hall of the Dundee laboratory, which he built and loved so well.

Yet another chemist, whose untimely death we have had to lament during the past twenty years, laboured with marked zeal in one of these new colleges, for it was at Aberystwyth that Humpidge, regardless of his delicate health and in spite of the altogether unreasonable burden of teaching duties imposed upon him by the terms of his appointment, contributed to our knowledge of the atomic weight of beryllium, and participated in establishing the position occupied by that metal in the natural classification of the elements.

Time does not permit me to further dilate upon the great activity displayed by many of the first occupants of the chairs of chemistry in these provincial University Colleges. It is also unnecessary for me to do more than remind you of the work accomplished by the two Colleges of the City and Guilds of London, the chemical laboratories of which have from their very inception been under the stimulating influences of Dr. Armstrong and Prof. Meldola, foci of research from which a number of young chemists of distinction have already emanated.

In recent years we have witnessed the genesis of another class of institution, less ambitious in their aspirations than the University Colleges, but indirectly also of much importance in their bearing upon the nurture of scientific chemistry in this country. I refer to the so-called Polytechnics which have sprung up in several parts of the metropolis, and to some other institutions of similar scope in different parts of the country. If research in the University Colleges has been the product of their professors rather than of the environment which they afford, assuredly this is even far more so in the case of these Polytechnics, which are primarily evening schools for the benefit of those who have other occupations during the day. That the young lecturers on chemistry at these places should find time and opportunity for original research, and that sometimes of a very high order, is indeed a brilliant testimonial to their indomitable energy and resourcefulness. Overburdened with large classes until late hours at night, often in those remote and hideous parts of London which suggest to most of us only Slumland and the philanthropic efforts of Toynbee Hall or of Dr. Barnardo, these young chemists awake in the morning only to return as rapidly as possible to those laboratories which exercise on them a fascination as subtle and magnetic as that which draws the commonplace Englishman to the golf-links, the cricket field, or the racecourse. It was in the laboratory of such a technical school, the Heriot Watt College, at Edinburgh, that my distinguished predecessor in this chair, my friend Prof. Perkin, created his opportunities for devising and carrying out those now classical methods of building up carbon rings which are the admiration of all organic chemists throughout the world; methods which he has recently brought to such a pitch of perfection that he is not only able to forge these rings in great variety, but to "bridge" them with links of carbon atoms. It was at the Heriot Watt College also that his work on berberin was performed, and it was here that he contracted that fertile alliance with Dr. Kipping, his able coadjutor in so many valuable investigations.

At the London Polytechnics, again, more recently, we have had similar examples of fertility, for are we not all familiar with the masterly work of Mr. W. J. Pope, who by his investigations at the Goldsmiths' Institute has extended our knowledge of asymmetric atoms, and has shown that optical activity, which hitherto had only been associated with carbon, and somewhat doubtfully with nitrogen, can certainly be produced, not only by asymmetric pentad nitrogen, but also by tetravalent tin and sulphur? Dr. Hewitt, again, whom I am proud to number among my former students, has shown that the laboratory of the People's Palace, Whitechapel, may be made a centre in which abstruse investigations on the aromatic compounds can be carried on.

There is, however, perhaps nothing which testifies more strongly to the zeal for original investigation amongst British chemists than the manner in which some of the science masters at our schools have participated in the advancement of chemical knowledge. Some of these schools have, indeed, from time to time secured the services of men whose names are indelibly engraved on the records of scientific chemistry, and it is from the laboratories of these schools that in some cases perhaps their best work has emanated. Of the chemical investigators who have laboured in school laboratories there occur to me, amongst the living, Debus and Clowes at Queenwood, Tilden and Shenstone at Clifton, Purdie at Newcastle-under-Lyme, Brereton Baker at Dulwich, Charles Baker at Shrewsbury. To these names might be added many more; indeed an examination of the list of Fellows of the Chemical Society shows at what a number of schools throughout the country the chemical teaching is now imparted by men who have themselves advanced the science which they profess.

From the conspicuous instances which I have brought before you—and they might, did time allow, be greatly multiplied—it must be obvious that if a chemist only possesses the necessary enthusiasm and qualifications he will, no matter how inauspicious his surroundings, succeed in doing something to extend the boundaries of his science, and I think I may go further and say without fear of contradiction that in this devotion to research the chemist in this country usually throws into the shade the representatives of other branches of science. How is this pre-eminent zeal of the British chemist to be explained? I believe that there are two principal causes in operation which have brought about this result. Firstly, the great majority of the higher chemical teachers in this country have been trained in Germany, or have been trained by men who were themselves trained there; and secondly, they have only in exceptional cases been educated at the ancient seats of learning. Their inspiration and enthusiasm are almost invariably directly or indirectly traceable to a German origin, and this fire is kept alive by their remaining in constant touch with German chemical literature.

It is being continually impressed upon us in the newspapers and dinned into our ears from every platform that it is imperative for this country to approximate more to German ideas and methods, and in general to cast away our insular prejudices, obstinacy, and self-satisfaction. We chemists have already done these things; we have emancipated ourselves from the mischievous illusions which have a tendency to thrive in a country enjoying an isolated geographical position. For, during the last half century the academic springs of Germany have been visited by a stream of young English chemists, a stream which, for the perennial regularity of its flow, reminds one indeed of the pilgrimage made by our fashionable invalids to the same country in the hope of correcting the effects of high living by the waters of Homburg, Kissingen, and Wiesbaden. There must indeed be few chemists who return from the German temples of science without bringing back at least a spark of the sacred fire to be kindled on an altar at home; and although at times it may be stifled by the island fog, or burn low through the scarcity of fuel, it generally smoulders long before going out altogether.

The chemist, again, is generally, as I have said, unfettered by an English university record: he stands or falls by the work of his life, and not, as so many others do, by the reputation which they have made in three short years of adolescence at one of the ancient seats of learning.

The spirit of research, which was formerly but a sporadic manifestation within the walls of these venerable institutions, has, however, now become endemic there also, and for a number of years past chemical literature has received a continuous stream of original communications from Oxford and Cambridge, as well as from the Universities of Scotland and Ireland. Instead of those occasional contributions which were customary in the past, we have now evidence that these centres in several cases yield to none in the energy and success with which chemical investigation is being pursued, and that the work of the chemical staff is being shared in by advanced pupils trained at these universities themselves. In this connection it is quite unnecessary for me to remind you of the contributions to British Chemistry within recent years by Crum Brown and his pupils at Edinburgh, by Japp at Aberdeen, by Purdie and James Walker at the duplex university now working so harmoniously north and south of the Tay, by Emerson Reynolds at Dublin, and by Harcourt and Harold Dixon, Liveing and Dewar, Ruhemann, Heycock and Neville, Fenton, Sell, Marsh and others, who have brought our science into such living prominence on the banks of the Cam and the Isis.

It is, however, not at home only that British chemists have displayed their devotion to research, for with the world-wide relations of the empire it has naturally fallen to the lot of some of our number to carry the science to the uttermost parts of the earth, but it is surely a matter of which we may be justly proud that some of these missionaries, like Mallett, Liversidge, Pedler and Rennie, have in these distant lands carried out a number of most important scientific investigations; whilst to one of them, Dr. Divers, belongs the great distinction, not only of having carried chemistry to the Far East, but of having reared a most active school of chemical research in that fascinating island empire of the rising sun and the chrysanthemum which has won the unfeigned admiration of the West.

The annals of British Chemistry are, however, by no means an exclusive record of the exploits of those engaged in the teaching of our science. I have already referred to the importance of the contributions made by men of leisure, but an equally noteworthy feature of British Chemistry is that its progress has been so often furthered by men who have snatched the time for investigation out of a busy professional or industrial life. Belonging to this category the names of a long line of distinguished chemists of our own time suggest themselves: Warren de la Rue, Hugo Müller, Sir John Lawes, Sir William Crookes, Sir William Abney, Peter Griess, Newlands, O'Sullivan, Horace and Adrian Brown, Harris Morris, Cross, and Bevan. To this group of chemists belongs also Dr. Ludwig Mond, whose technical researches have been of such great value to industrial chemistry, whilst his devotion to the pure science is attested by his interesting discovery and investigation of the metallic carbonyl compounds, and by his conception and munificent endowment of the Davy-Faraday Laboratory, in which such unique opportunities for research have been provided by him.

This would appear to be the most fitting moment also to refer to certain other institutions intended for purposes of research which have been established during the past twenty-five years. Of these the first is the Rothamsted Laboratory, so celebrated during the last half-century for the memorable investigations of Lawes, Gilbert, Pugh, and Warington, but which has more recently, through the generosity of the late Sir John Lawes, been rendered a permanent home for the elucidation of agricultural problems both by laboratory experiments and by trials in the field. Secondly, there is the Research Laboratory which the Pharmaceutical Society has established with the view of raising to a higher level the chemical education of its most promising future members. This laboratory has furnished the opportunity for the valuable investigations of its first director, Prof. Dunstan, and of his successor, Dr. Collie. Still more recently a chemical research laboratory has been established in the Imperial Institute. That noble building has within the last few years undergone a process of transverse subdivision, one-half having assumed an independent existence as the nucleus of that still crystallising body, the University of London; whilst in the remaining half the work of the Institute is now carried on in such silence that we have almost forgotten its existence. For where is the florid music with which on summer nights the air of South Kensington was wont to reverberate? Gone. Gone also are the tea-tables, the gardens with their million fairy lights, and the promenading crowds in gay attire. But if the Institute, founded by public subscription to watch over and advance the prosperity of the British dominions, has been impoverished by the discontinuance of these revels, it has become enriched and has gained in dignity by the creation within its walls of a Research Laboratory in which Prof. Dunstan and his assistants are busily investigating the chemical nature of numerous interesting products obtained from all parts of Greater Britain.

There can, in my opinion, be no doubt that this much extended cultivation of scientific chemistry in this country, which is such a noticeable feature of the concluding years of the nineteenth century, has been greatly assisted by a most fortunate, and more or less accidental, circumstance, without which the energy and enthusiasm of our chemical teachers would have been seriously restricted in their influence. I refer to the very substantial surplus, producing an income of 6000*l.* to 7000*l.* a year, of which the Commissioners of the 1851 Exhibition found themselves possessed, and its utilisation on the advice of the late Lord Playfair for the purpose of the Research Scholarships which have for some ten years past been so highly prized by all the educational institutions permitted to participate in them. The good wrought by these scholarships has been very far-reaching, and it would be difficult to praise too highly the wisdom displayed by the Commissioners in drawing up the conditions on which they are awarded. Firstly, by not limiting them to any one science, they have stimulated a wholesome rivalry between departments to bring on their promising students to the level of scientific investigation. Secondly, they have compelled the governing bodies of educational institutions to recognise and make provision for research as part of the regular programme of these places. Thirdly, they have encouraged talented students to devote an additional year, or even more, to their education in the hope of securing one of these prizes; and these students have thus provided their teachers with the *personnel* necessary for carrying on scientific work. Fourthly, the scholars themselves have had the inestimable advantage of extending their horizon, and of coming in contact with other teachers, other schools of thought, and other views of life. Fifthly, these scholars on their return, and before they have obtained definite employment, are welcomed as supernumeraries in English colleges, where they have an opportunity of continuing their researches, and where they assist in imbuing the students with the spirit which they have themselves imbibed. Lastly, these and other scholarships of a similar character are providing the country with a body of highly trained men whose value to the nation is annually becoming more appreciated, and whose work will continue to bear fruit directly or indirectly for an indefinite period of time. These Exhibition scholarships have now been awarded since 1891, and already no fewer than sixty-five chemists, including three women, have enjoyed the enormous privilege of extending their education for a period of two, and in special cases even three, years under the most favourable surroundings.

Bearing in mind the rooted objection which pervades the people of this country to expend any public money on higher education, it is marvellous that it should have been possible to employ this fund, which after all is of a quasi-public character, for what may be described as educational use at a high potential, instead of its being dissipated in the manner so dear to Englishmen, by benefiting to an infinitesimal extent a much larger number of persons. Indeed, but for the vertebrate character of the Commissioners in 1877, the fund would have been thus frittered away, for in that year they were waited upon by a deputation of influential persons who urged that the money should be distributed in grants to provincial museums. Had that been done what would have been the result? The masses would have had a few more glass cases to gaze at on wet days and bank holidays!

There can, I think, be little doubt that in this matter of the allocation of funds intended for the public good we have reached a turning-point in the road which we have been so long pursuing. Until recently it has been the feeling of a very powerful majority in this country that public money should only be spent in such a way as to directly benefit very large numbers; and in the case of educational funds, therefore, it was only their utilisation for the benefit of the masses that could be entertained. Now, whilst it is indubitable that the improvement of our primary education was for many years a crying necessity, it has long been obvious to a minority that this policy is systematically starving that higher education in which we are lagging more and more behind those other countries in which greater elasticity prevails, and in which the immediate and obvious wants of the community receive prompt attention without regard to the traditions and doctrinaire principles of a past generation. In the matter of higher scientific education, at any rate, it is becoming more and more widely recognised that its starvation through attention being exclusively directed to the low-level education of the masses is defeating the very ends which this policy has in view. Indeed, some practical men, and even a few statesmen, realise that the many are beginning to suffer from the results which this policy has had on our manufactures and commerce, without which the multitude can have no existence at all.

The more than princely patronage of higher education by that Scotsman who has not forgotten the land of his birth during fifty years spent in a country which has afforded the necessary scope for his genius and energies illustrates the change in the wind of opinion amongst practical men; for Mr. Andrew Carnegie's handsome contribution to the funds of the University of Birmingham, and his endowment of the Universities of Scotland on a scale which is altogether without precedent, clearly show which, in his opinion, are the rungs in the educational ladder of this country that require strengthening in the interest of those very masses which it is his earnest desire to benefit. The still more recent response of the City Council of Birmingham to Mr. Chamberlain's suggestion that a rate should be levied in aid of the university of that city is further evidence that Mr. Carnegie's practically expressed opinion is shared by the enlightened rulers of that great municipality to which I have the privilege of belonging.

These, ladies and gentlemen, are, I believe, no mere sporadic manifestations, but unquestionably signs of the times. The opening of the new century is in reality a year of very serious awakening to those Englishmen who are not deaf to the voices in the air around them. It is rapidly dawning upon many that "the greatest empire which the world has ever seen" cannot be maintained unless we cast off insular prejudices and traditions, and make a careful study of those points in which other nations are our superiors, with a view to the intelligent adaptation and development, as distinguished from mere imitation, of their methods to our own particular needs.

The survey of the British chemical world at the dawn of the twentieth century affords, however, scope for satisfaction in many ways. Not only have the places in which higher chemical work can be and actually is carried on been greatly multiplied, but the number of workers has been largely increased; and although the enthusiasm of these workers cannot well be greater than that of those who laboured so successfully twenty years and more ago, it has not become diminished, and is certainly diffused more widely amongst the *personnel* of our colleges and universities. In this connection I need only remind you of the large number of active and independent investigators who are to be found amongst the members of the junior staff at almost every college in the country, and which is altogether without parallel in the past.

There are hardly any of the great problems now exercising the minds of chemists throughout the world which are not being worked at by some of our number; whilst that some chapters in the recent progress of chemical science are more or less specifically British, I would only remind you of the isolated labours of Dr. Perkin in the field of magnetic rotatory power; of Sir William Crookes's exploration of the phenomena occurring in high vacua; of the researches of Abney, Russell, and Hartley on the absorption spectra of organic compounds; of the investigations by Harold Dixon and Brereton Baker of the behaviour of substances in the complete absence of moisture; of the extension by Pope and Smiles of our knowledge of asymmetric atoms; of the near approach to the absolute zero of temperature by Dewar; and of those marvellous discoveries of Raleigh and Ramsay which have not only introduced us to five new aërial elements, but have revealed the existence of a hitherto unknown type of matter, which is apparently incapable of entering into chemical combination at all.

But whilst we may thus congratulate ourselves on this increased activity in chemical investigation, and upon the maintenance of a high standard of quality by the exceptional brilliancy of the researches of some of our number, we must now carefully consider how we stand with regard to the absolute quantity of our output.

I have called your attention to the evidence of activity in the British chemical world which is furnished by the number of original investigations communicated to the Chemical Society of London. Let me now ask you to turn to the corresponding picture, which is furnished by the statistics of the much younger Chemical Society of Berlin.

Original Communications to the Chemical Society of Berlin.

1868	... 97	1877	... 568	1886	... 696	1895	... 636
1869	... 252	1878	... 602	1887	... 708	1896	... 566
1870	... 277	1879	... 604	1888	... 658	1897	... 560
1871	... 288	1880	... 563	1889	... 601	1898	... 555
1872	... 303	•1881	... 495	1890	... 630	1899	... 549
1873	... 420	1882	... 541	1891	... 677	1900	... 636
1874	... 516	1883	... 535	1892	... 553		
1875	... 488	1884	... 646	1893	... 587		
1876	... 517	1885	... 686	1894	... 653		

A comparison between these figures and those of the London Chemical Society shows that chemical science occupies an entirely different place in Germany from that which it even now does in this country.

Is this state of affairs to continue throughout the twentieth century? Are intellectual ambitions to be for ever subordinated to the extension of territory, to the acquisition of that metal which has had its atomic weight so accurately determined by Thorpe and Laurie, and to those other problems which fill the political horizon? Even the most recent awakening of interest in higher scientific education is not altogether of the breed to satisfy us as men of science; for the interest is assuredly not in the pursuit of knowledge for its own sake, but is aroused by the desire to secure those material advantages which it is beginning to be realised must inevitably result from the steadfast prosecution of scientific research. This is indeed a very different spirit from that which has led to the proud position occupied by science and learning of all kinds in Germany.

Schiller has truly said—

"Knowledge is to one a goddess, to another only an excellent cow."

I fear there can be no doubt that here it is the cow, and not the goddess, that is in request. Thus, whilst in Germany the love and reverence for knowledge preceded the esteem of knowledge for the material benefits which it confers, we must hope that in our country the eagerness to secure the material advantages will perhaps lead to a love and reverence for that which confers them, so that in the course of time, perhaps, the useful cow will be allotted a stall on Olympus, or be at least pastured on the grass of Parnassus.

From whatever motive, whether utilitarian or otherwise, we wish to see the position of science in this country raised, and the qualitative and quantitative output of scientific work increased, I imagine that the methods to be immediately pursued for attaining this end must be very similar.

If the higher teaching of science is to be really encouraged the first necessity is that this higher teaching shall offer a sufficiently attractive career to the man of ambition as well as to the enthusiast. We all know that the supply of enthusiasts of intellectual power combined with capacity to perform is extremely limited and wholly inadequate for carrying out the important work of the world, and that the greater part of such work is actually done by men of ambition.

In order that the academic world may attract the ablest men of ambition as well as that *rara avis*, the able enthusiast, it is necessary that the highest prizes for academic distinction should carry similar social prestige, similar remuneration, and similar opportunities of exerting public influence as are enjoyed by the leaders of other professional callings: they should be at least equal to those of the Archbishop of Canterbury or of the Lord Chancellor. It is not by any means necessary that such prizes should be numerous, as is abundantly demonstrated by the volume of able ambition which is drawn into the Church and to the Bar by the comparatively few opportunities for great success in those professions. The enthusiasts already find their way into the academic world, and, although they maintain the quality of British scientific work, they are unable, by virtue of their scarcity, to maintain the quantity which is essential for the luxuriant growth of science in our midst, whilst the absence of such tangible rewards as are bestowed in other spheres of intellectual activity prevent the importance of science being recognised by a public which has no appreciation of the inward and spiritual grace unless guided by the outward and visible sign.

Precisely the opposite policy, so far as remuneration is concerned, has, however, been pursued in the academic world during recent years, the few very moderate prizes which formerly existed having been deliberately commandeered to more nearly equalise the value of the chairs in all departments.

The principle of equalising the remuneration of different chairs is as inequitable as it is utterly unsound from a business point of view. The principle is unsound because equal salaries will not secure men of similar standing in different subjects: it is inequitable because the amount of work attaching to the chairs of different subjects is necessarily very unequal, as is the order of intellect required for the successful discharge of their duties.

Again, the system which is gaining ground in this country of allocating a certain stipend to a chair is unbusinesslike and mischievous. It is as irrational to fix the remuneration of a particular chair as it would be to fix the price to be paid for one's portrait, irrespectively of whether it were taken by a photographer or painted by a Royal Academician. If we really want the best man for any particular professional service, whether it be to treat us for a disease, to plead our cause in a court of law, or to perform on some musical instrument for our delectation, we know that we must make up our minds to pay the price which the best man commands in his particular profession, and it is absurd to suppose that the same principle does not hold good in the matter of securing the best man for an academic appointment. This, again, is intimately connected with the desirability of providing a sufficient number of steps in the academic ladder, so that it shall not be possible for the "young man of promise" to be rushed into a first-class appointment from which he has no ambition to move for the remainder of his days.

Another matter, again, requires consideration: if we are really in earnest in the attempt to bring our universities abreast of those in other countries, our chairs must be systematically thrown open to the whole world, and the best men obtainable secured, irrespectively of their nationality. Not only have small nations adopted this plan, but even the nation which is preeminent for its academic strength is by no means blind to the importance of drawing into its service from the outside men of commanding brilliance and power. I need not remind you that England has also exhibited a wise and liberal spirit in this matter in the past, and that, so far as our science is concerned, this policy has been most fully justified. For, consider only what the English Chemistry of the latter half of the nineteenth century owes to the genius and magnetic influence of the imported Hofmann. I can imagine the electors to British chairs suggesting that there might be linguistic difficulties in the way of carrying out such a policy, in answer to which I would appeal to the pupils of Hofmann to say whether his stimulating discourse lost anything of its vigour and inspiration through the strong Hessian accent with which every word of it was saturated. It is to be hoped that no narrow and short-sighted policy, disguised under that too often misused word "patriotism," will seek to close the doors of our universities to the genius and ability of other nationalities.

I believe, however, that one of the most urgent and pressing of University reforms is that greater facilities should be afforded for the migration of students from one university to another, without prejudice to their acquisition of a degree. It is the present system, which practically chains an undergraduate with links of steel to the university at which he matriculates, that is at the root of many of the evils under which our higher education is labouring.

The university at which a youth matriculates is often determined by the fatuous, although pathetic, wish of the father that his son should spend his time, I will not say work, amidst the surroundings which awaken such pleasant memories in himself; and the youth once within the magic portals has little or no opportunity of rectifying the possible mistake of his fond parent, who has probably for a quarter of a century been quite out of touch with university matters, or even divorced from the intellectual world altogether.

This foolish sentiment of loyalty to a university or even college is sometimes kept up for generations, and I have met persons who have told me that their family had always been Balliol or Trinity men, with the same sort of pride that they would doubtless have informed me, had they been able, that their ancestors came over with the Conqueror or had charged with the Cavaliers at Naseby.

The prevalence of such a sentiment shows that our universities are principally valued for their social attractions, as well as for their past history and ancient traditions, in which connection it is always well to remember that a living dog is better than a dead lion.

The possibility of students dissociating themselves from the university of their matriculation and freely migrating from one school to another would, in my opinion, not only be of immense advantage to the students themselves, enabling them to obtain the best instruction in each particular subject and greatly extending their horizon and knowledge of the world, but it would operate most favourably on the universities themselves, minimising the tendency to stagnation, and compelling those who hold the purse-strings to provide for the strengthening of weak departments. Nor should the possibilities of migration be limited to the Universities of the United Kingdom or even of the British Empire, but the prospect should be kept in view of ultimately effecting an arrangement whereby students could enjoy the advantage of visiting the universities of other countries.

Such migration is, of course, closely connected with the duration of the period of university study, and in this matter reform is most urgently needed. The traditional three years devoted to the acquisition of a degree is hopelessly inadequate for the higher purposes of university training, especially when the very immature age at which English students generally begin their university career is taken into consideration. The period of academic study should be forthwith extended to five years, as it is only in this way that the university can be effectively made a centre of research. Without a course of study of such duration, and of which research forms a part, it is quite impossible that the highly trained men who are now so urgently needed for practical avocations should be produced.

In this connection, again, we all know that much mischief has been going on in recent years. Instead of the terms on which degrees are at present obtainable being regarded as too lenient and easy, proposals are actually being put forward in some quarters to enable persons attending evening classes to thereby qualify for university degrees. Now, whilst it is of the utmost importance to provide abundant opportunities for the talented poor to obtain a university education by reducing the fees and by instituting a sufficient number of bursaries, it is imperative that those who are to be stamped with the distinctive mark of a university should have devoted their whole and undivided attention, over a certain period of time, to the courses of study prescribed. Let us beware of introducing the half-time system into the university, a system which we know to be a deplorable makeshift even in the elementary school.

In this matter of the aspirations, scope and functions of a university we have not merely to contend with the ignorance and apathy of the average Philistine, but we are wrestling against principalities, against powers and against darkness in high places. Thus only four months ago one of our most prominent statesmen, whose oracular and sporadic utterances inspire amongst millions almost the awe and respect which is felt for the supernatural, is reported in the columns of the daily papers to have said at one of the most important educational gatherings of this first year of the new century:—"You, Mr. Vice-Chancellor, spoke of the stigma that would rest on the University if it did not annually produce some work of original research. I, from another point of view, am contented if you do nothing of the kind. I am satisfied to think that in a large and increasing degree you will train men and women fit for the manifold requirements of this Empire." This statesman, who it is not surprising to find was educated at Eton and Oxford, is thus of the opinion to-day, unless, indeed, his views have changed in the interim, that it is possible to train men and women fit for the manifold requirements of this Empire without bringing, at any rate, some of them into contact with the living spirit of research—that spirit which, operating through the ages, has enabled man to transform the wilderness in which he was placed by his Creator into the garden of material and intellectual enjoyments in which that statesman was himself born.

I would ask you to contrast with the views of the distinguished *alumnus* of Eton and Oxford the utterance of another statesman who, unhampered by such educational antecedents, has formulated the following ideal for the guidance of that university which he has himself created:—

"The third feature to which I should call attention, and which, I am inclined to say, is of all the most important, is that a university should be a place where knowledge is increased, and where the limits of learning are extended. Original research, the addition of something to the total sum of human knowledge, must always be an essential part of our proposals."

Lastly, we have to consider whether this university work, in which we hope for such great developments in the twentieth century, is still to be carried on by what is virtually private enterprise and private endowment, or whether it is to be provided for by taxation.

If the reforms and developments which are being preached from so many platforms are to be really carried out, if even our higher scientific training alone is to be brought into line with that which is provided in many other countries, it is indubitable that expenditure will have to be enormously increased. Now, profoundly as we all admire the enlightened public spirit of the men and women who have in the past endeavoured out of their private resources to help forward the great movement of higher education, it is, I believe, the firm conviction of all who have any real knowledge of what this higher education means, and a clear conception of what must be done in order to put it on a proper footing in this country, that on private benefaction alone this work cannot be accomplished. But even if private endowment could raise this great edifice in our midst, it is obvious that we should have to wait indefinitely for its realisation. Voluntary contributions cannot be made to come at the bidding of those who stand in need, nor directed into the channels where they will produce the most good; they have to be patiently waited for, with the result that valuable time is lost and opportunities pass by never to return. Private benefaction, moreover, is almost always retrospective: a hospital is not founded by the charitable until the sick are dying unattended; almshouses and orphanages are not thought of until the widow and the fatherless are either starving in the streets or begging on the doorstep. What we so forcibly recognise in this matter, however, is that we have not only to make up for leeway in the past, but that we must now exercise prevision to prevent similar disastrous lapses in the future. The state of affairs to which we have been reduced must not be allowed to occur again; the warnings of those possessing special knowledge in these matters must not be disregarded in the future as they have been in the past, for it is no exaggeration that the whole of the learned societies and academic bodies of this country put together have at present a smaller corporate share of political influence than a Temperance League or a Trades Union. To what has this state of things reduced us? The humiliating spectacle of "the greatest empire the world has ever seen" at the beginning of the twentieth century without a teaching university in its metropolis, and engaged upon the task of tardily patching one together out of those heterogeneous elements of uncertain valency which are to hand. Is the completion of this structure, on a scale challenging comparison with the universities which are to be found in the other great capitals of Europe, to be delayed until a millionaire, or rather series of millionaires, can be induced to finance it? To this work, and to other works like it, is it not fitting that every inhabitant of this country should contribute? For these are works which assuredly benefit all classes, not only of this generation, but of those which are to come—at least as much as the acquisition of territory at a distance of 8000 miles from home, and for which purpose the nation is apparently willing to pay at the rate of one and a quarter million sterling per week for an indefinite period of time.

It is sometimes urged that this higher education does not benefit the masses; but could any contention be more erroneous? The poor have really a far greater stake in the prosperity of our home industries and commerce than the rich; for whilst the decay of our producing power will remove the very means of subsistence from the poor, it matters very little to many of the rich whether their dividends are derived from home-enterprises or from those of a Billion Dollar Combine or some similar transatlantic Trust or Corporation.

Higher education and true universities are also amongst the most potent factors in breaking down the hereditary stratification of society and in minimising the advantages depending upon the accident of birth, so that, with the greatly enhanced facilities which must be provided for students without means, they should afford in the future, even more than they have done in the past, an avenue for the humblest boy of talent to that position which he is by natural endowment and by his own exertion best fitted to fill in the interests of the State.

Is this great work of raising up a worthy system of national higher education, and of creating a living interest and widely diffused enthusiasm for knowledge and for the increase of knowledge in all its branches, going to be accomplished during the century of which we have but crossed the threshold? Even the most sanguine among us dare not unhesitatingly say Yes; but assuredly upon the answer, which is hidden by the veil of the inscrutable future, depends in the very highest degree, not only the material and intellectual welfare of the rising generations, but also the good name and reputation of the Empire in our own time and the gratitude which, above all things, we should strive to earn from that immortal part of us which we call Posterity.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY JOHN HORNE, F.R.S., F.R.S.E., F.G.S., PRESIDENT OF THE SECTION.

Recent Advances in Scottish Geology.

A QUARTER of a century has elapsed since the British Association met in this great industrial centre, when Prof. Young, in his presidential address to this Section, pointed out some of the difficulties which, as a teacher, he experienced in summarising the principles of geology for his students. At that meeting, also, the late Duke of Argyll. whose interest in geological questions never faded, gave an address "On the Physical Structure of the Highlands in connection with their Geological History." The return of the Association to the second city of the empire, which since 1876 has undergone remarkable development, due in no small measure to the mineral wealth of the surrounding district, suggests the question, Has Scottish geology made important advances during this interval of time? Have we now more definite knowledge of the geological systems represented in Scotland, of their structural relations, of the principles of mountain-building, of the zonal distribution of organic remains, of the volcanic, plutonic, and metamorphic rocks so largely developed within its borders? It is true that many problems still await solution, but anyone acquainted with the history of geological research must answer these questions without hesitation in the affirmative. In the three great divisions of geological investigation—in stratigraphical geology, in palæontology, in petrology—the progress has indeed been remarkable. The details of these researches are doubtless familiar to many who have taken an active share in the work, but it may serve a useful purpose, and perhaps be helpful as a landmark to give now an outline of some of the permanent advances in the solid geology of Scotland during the last quarter of a century.

The belt of Archæan gneisses and schists, which may be said to form the foundation stones of Scotland, have been mapped in great detail by the Geological Survey since 1883 along the western part of the mainland in the counties of Sutherland and Ross. In that region they occupy a well-defined position, being demonstrably older than the great sedimentary formation of Torridon Sandstone and overlying Cambrian strata. The mapping of this belt by the survey staff and the detailed study of the rocks both in the field and with the microscope by Mr. Teall have revealed the complexity of the structural relations of these crystalline masses, and have likewise thrown considerable light on their history. These researches indicate that, in the North-west Highlands, the Lewisian (Archæan) gneiss may be resolved into (1) a fundamental complex, composed mainly of gneisses that have affinities with plutonic igneous products, and to a limited extent of crystalline schists which may without doubt be regarded as of sedimentary origin; (2) a great series of igneous rocks intrusive in the fundamental complex in the form of dykes and sills.[1]

The rocks of the fundamental complex which have affinities with plutonic igneous products occupy the greater part of the tract between Cape Wrath and Skye. Mr. Teall has shown that they are essentially composed of minerals that enter into the composition of peridotites, gabbros, diorites, and granites; as, for example, olivine, hypersthene, augite (including diallage), hornblende, biotite, plagioclase, orthoclase, microcline, and quartz. In 1894 he advanced a classification of these rocks, based mainly on their mineralogical composition and partly on their structure, which has the great merit of being clear, comprehensive, and independent of theoretical views as to the history of the rock masses. Stated broadly, the principle forming the basis of classification of three of the groups is the nature of the dominant ferro-magnesian constituent, viz., pyroxene, hornblende, or biotite, while the members of the fourth group are composed of ferro-magnesian minerals without felspar or quartz ("Annual Report of the Geological Survey for 1894," p. 280). The detailed mapping of the region has shown that these rock-groups have a more or less definite geographical distribution. Hence the belt of Lewisian gneiss has been divided into three districts; the first extending from Cape Wrath to Loch Laxford; the second, from near Scourie to beyond Lochinver, and the third from Gruinard Bay to the island of Raasay. In the central area (Scourie to Lochinver) pyroxene gneisses and ultrabasic rocks (pyroxenites and hornblendites) are specially developed, while the granular hornblende rocks (hornblende gneiss proper) and the biotite gneisses are characteristic of the northern and southern tracts. These are the facts, whatever theory he adopted to explain them.

In those areas where the original structures of the Lewisian gneiss have not been effaced by later mechanical stresses it is possible to trace knots, bands, and lenticles of unfoliated, ultrabasic, and basic rocks to note the imperfect separation of the ferro-magnesian from the quartzo-felspathic constituents, to observe the gradual development of mineral banding and the net-like ramification of acid veins in the massive gneisses. Many of these rocks cannot be appropriately described as gneiss. Indeed, Mr. Teall has called attention to the close analogy between these structures and those of plutonic masses of younger date.

In the Report on Survey Work in the North-west Highlands, published in 1888, the parallel banding, or first foliation, as it was then termed, of these original gneisses was ascribed to mechanical movement (*Quart. Journ. Geol. Soc.*, vol. xliv. p. 400). But the paper on "Banded Structure of Tertiary Gabbros in Skye," by Sir A. Geikie and Mr. Teall (*ibid.*, vol. l. p. 645), throws fresh light on this question. In that region the gabbro displays the alternation of acid and basic folia, the crumpling and folding of the bands like the massive gneisses of the Lewisian complex. Obviously in the Skye gabbro the structures cannot be due to subsequent earth movements and deformation. The authors maintain that they are original structures of the molten magma, and, consequently, that much of the mineral banding of the Lewisian gneisses, as distinguished from foliation, may be due to the conditions under which the igneous magma was erupted and consolidated. Whatever theory be adopted to explain the original mineral banding of the Lewisian gneisses, it is certain that they possessed this banding, and were thrown into gentle folds before the uprise of the latter intrusive dykes.

The crystalline schists that have affinities with rocks of sedimentary origin occupy limited areas north of Loch Maree and near Gairloch. The prominent members of this series are quartz schists, mica schists, graphitic schists, limestones and dolomites with tremolite, garnet and epidote ("Annual Report of the Geological Survey for 1895," p. 17). They are there associated with a massive sill of epidiorite and hornblende schist. The relations which these altered sediments bear to the gneisses that have affinities with plutonic igneous products have not been satisfactorily determined. But the detailed mapping has proved that north of Loch Maree they rest on a platform of Lewisian gneiss, and are visibly overlain by gneiss with basic dykes (Meall Riabhach), and that both the gneiss complex and altered sediments have been affected by a common system of folds. In the field, bands of mylonised rock have been traced near the base of the overlying cake of gneiss, and the microscopic examination of the latter by Mr. Teall has revealed cataclastic structures due to dynamic movement. It is obvious, therefore, that, whatever may have been the original relations of the altered sediments to the gneiss complex, these have been obscured by subsequent earth-stresses.

The great series of later igneous rocks which pierce the fundamental complex in the form of dykes and sills is one of the remarkable features in the history of the Lewisian gneiss. In 1895 Mr. Teall advanced a classification of them (*ibid.*, p. 18), but his recent researches show that they are of a much more varied character. For our present purpose we may omit the dykes of peculiar composition and refer to the dominant types. These comprise: (1) ultrabasic rocks (peridotite), (2) basic (dolerite and epidiorite), and (3) acid (granite and pegmatite). The evidence in the field points to the conclusion that the ultrabasic rocks cut the basic, and that the granite dykes were intruded into the gneisses after the eruption of the basis dykes. The greater number of these dykes consists of basic materials. It is important to note that the basic rocks best preserve their normal dyke-like features in the central tract between Scourie and Lochinver, where they traverse the pyroxene gneisses. But southwards and northwards of that tract, in districts where they have been subjected to great dynamic movement, they appear as bands of hornblende-schist, which are difficult to separate from the fundamental complex. The acid intrusions are largely developed in the northern tract between Laxford and Durness; indeed, at certain localities in that region the massive and foliated granite and pegmatite are as conspicuous as the biotite gneisses and hornblende gneisses with which they are associated.

After the eruption of the various intrusive dykes the whole area was subjected to enormous terrestrial stresses which profoundly affected the fundamental complex and the dykes which traverse it. These lines of movement traverse the Lewisian plateau in various directions, producing planes of disruption, molecular rearrangement of the minerals and the development of foliation. It seems to be a general law that the new planes

[1] Report on the Recent Work of the Geological Survey in the North-west Highlands of Scotland based on the Field-notes and Maps of Messrs. B. N. Peach, J. Horne, W. Gunn, C. T. Clough, L. W. Hinxman, and H. M. Cadell, *Quart. Journ. Geol. Soc.*, vol. xliv. p. 387; and "Annual Report of the Geological Survey for 1894," p. 280, and 1895, p. 17.

of foliation both in the gneiss and dykes are more or less parallel with the planes of movement or disruption. If the latter be vertical or nearly horizontal the inclination of the foliation planes is found to vary accordingly.

Close to the well-defined disruption-planes, like those between Scourie and Kylesku, the gneiss loses its low angle, is thrown into sharp folds, the axes of which are parallel with the planes of movement. The folia are attenuated, there is a molecular re-arrangement of the minerals, and the resultant rock is a granulitic gneiss. Indeed, the evidence in the field, which has been confirmed by the microscopic examination of the rocks by Mr. Teall, seems to show that granulitic biotite and hornblende gneisses are characteristic of the zones of secondary shear. A further result of these earth-stresses is the plication of the original gneisses in sharp folds, trending N.W. and S.E. and E. and W.; and the partial or complete recrystallisation of the rocks along the old planes of mineral banding.

In like manner, when the basic dykes are obliquely traversed by lines of disruption, they are deflected, attenuated, and within the shear zones appear frequently as phacoidal masses amid the reconstructed gneiss. These phenomena are accompanied by the recrystallisation of the rock and its metamorphosis into hornblende schist. Similar results are observable when the lines of movement are parallel with the course of the dykes. All the stages of change from the massive to the schistose rock can be traced—the replacement of pyroxene by hornblende, the conversion of the felspar and the development of granulitic structure with foliation. Here we have an example of the phenomena developed on a larger scale by the post-Cambrian movements, viz., the production of common planes of schistosity in rocks separated by a vast interval of time, quite irrespective of their original relations. For both gneiss and dykes have common planes of foliation, resulting from earth-stresses in pre-Torridonian time.

It is important to note also that linear foliation is developed in the basic dykes where there has been differential movement of the constituents in folded areas. In the case of the anticline mapped by Mr. Clough, near Poolewe in Ross-shire, he has shown that the linear foliation is parallel with the pitch of the folds. All these phenomena tend to confirm the conclusions arrived at by Mr. Teall, and published in his well-known paper, "On the Metamorphosis of Dolerite into Hornblende Schist" (*Quart. Journ. Geol. Soc.*, vol. xli. p. 133).

The ultrabasic and acid rocks likewise occur in the schistose form, for the peridotites pass into talcose schists and the granite becomes gneissose.

In connection with the development of schistosity in these later intrusive rocks it is interesting to observe that where the basic dykes merge completely into hornblende schist, and seem to become an integral part of the fundamental complex, biotite gneisses and granular hornblende gneisses prevail. Whatever be the explanation, the relationship is suggestive.

The unconformability between the Lewisian gneiss and the overlying Torridon Sandstone, which was noted by Macculloch and confirmed by later observers, must represent a vast lapse of time. When tracing this base-line southwards through the counties of Sutherland and Ross, striking evidence was obtained by the Geological Survey of the denudation of that old land surface. In the mountainous region between Loch Maree and Loch Broom it has been carved into a series of deep narrow valleys with mountains rising to a height of 2000 feet. In that region it is possible to trace the orientation of that buried mountain chain and the direction of some of the old river courses. This remnant of Archæan topography must be regarded as one of the remarkable features of that interesting region.

In 1893 the various divisions of the Torridon Sandstone, as developed between Cape Wrath and Skye, were tabulated by the Geological Survey, which may here be briefly summarised. They form three groups: a lower, composed of epidotic grits and conglomerates, dark and grey shales with calcareous bands, red sandstones, and grits; a middle, consisting of a great succession of false-bedded grits and sandstones; an upper, comprising chocolate-coloured sandstones, micaceous flags with dark shales and calcareous bands. The total thickness of this great pile of sedimentary deposits must be upwards of 10,000 feet, and if Mr. Clough's estimate of the development of the lower group in Skye be correct, this amount must be considerably increased. Of special interest is the evidence bearing on the stratigraphical variation of the Torridon Sandstone when traced southwards across the counties of Sutherland and Ross. The lower group is not represented in the northern area, but southwards, in Ross-shire, it appears, and between Loch Maree and Sleat varies from 500 to several thousand feet in thickness. These divisions of the Torridon Sandstone are of importance in view of the correlation of certain sediments in Islay with the middle and lower Torridonian groups which there rest unconformably on a platform of Lewisian gneiss.

In continuation of the researches of Dr. Hicks, published in his paper "On pre-Cambrian Rocks occurring as Fragments in the Cambrian Conglomerates in Britain" (*Geol. Mag.*, 1890, p. 516), Mr. Teall has specially investigated the pebbles found in the Torridon Sandstone. The local basement breccias of that formation have doubtless been derived from the platform of Lewisian gneiss on which they rest, but the pebbles found in the coarse arkose tell a different story ("Annual Report of the Geological Survey for 1895," p. 20). He has found that they comprise quartzites showing contact alteration, black and yellow cherts, jaspers with spherulitic structures which indicate that they have been formed by the silification of liparites of the "Lea-rock" type and spherulitic felsites that bear a striking resemblance to those of Uriconian age in Shropshire. These interesting relics have been derived from formations which do not now occur anywhere in the western part of the counties of Sutherland and Ross, and they furnish impressive testimony of the denudation of the Archæan plateau in pre-Torridonian time.

These Torridonian sediments, like the sandstones of younger date, contain lines of heavy minerals, such as magnetite, ilmenite, zircon, and rutile ("Annual Report of the Geological Survey for 1893," p. 263). The dominant felspar of the arkose group is microcline, that of the basal group oligoclase. In the calcareous sediments of the upper and lower groups fossils might naturally be expected, but the search so far has not been very successful. Certain phosphatic nodules have been found in dark micaceous shales of the upper group which have been examined by Mr. Teall. From their chemical composition these nodules might be regarded as of organic origin; but he has found that they contain spherical cells with brown-coloured fibres, which appear to be débris of organisms (*ibid.*, 1899, p. 185).

Early in last century the Torridonian deposits were referred by Macculloch (*Trans.* Geol. Soc., ser. 1, vol. ii. p. 450; "The Western Isles of Scotland," vol. ii. p. 89) and Hay Cunningham (*Transactions* of the Highland and Agricultural Society of Scotland, vol. xiii. 1839) to the "Primary Red Sandstone," and by Murchison (*Trans.* Geol. Soc., ser. 2, vol. iii. p. 155), Sedgwick, and Hugh Miller to the Old Red Sandstone. The structural relations of the Torridon Sandstone to the overlying series of quartzites and limestones were first clearly shown by Prof. Nicol (*Quart. Journ. Geol. Soc.*, vol. xiii. p. 17), who traced the unconformability that separates them for 100 miles across the counties of Sutherland and Ross. When Salter pointed out the Silurian facies of the fossils found in the Durness limestone by Mr. Charles Peach, the Torridonian formation was correlated with the Cambrian rocks of Wales by Murchison (*ibid.*, vol. xv. p. 353). The discovery of the *Olenellus* fauna, indicating the lowest division of the Cambrian system, in the quartzite-limestone series by the Geological Survey in 1891 (*ibid.*, vol. xlviii. p. 227) demonstrated the pre-Cambrian age of the Torridon Sandstone. In view of that discovery, which proves the great antiquity o. the Torridonian sediments, it is impossible to climb those picturesque mountains in Assynt or Applecross without being impressed with the unaltered character of these deposits. Yet it can be shown that under the influence of post-Cambrian movements they approach the type of crystalline schists.

Before proceeding to the consideration of the Durness series of quartzites and limestones and their relations to the Eastern Schists, brief reference must be made to the controversy between Murchison and Nicol regarding the sequence of the strata.

The detailed mapping of the belt between Eriboll and Skye by the Geological Survey has completely confirmed Nicol's conclusions (1) that the limestone is the highest member of the Durness series; (2) that the so-called "Upper Quartzite" and "Upper Limestone" of Murchison's sections are merely the repetition of the lower quartzite and limestone due to faults or folds; (3) that there is no conformable sequence from the quartzites and limestones into the overlying schists and gneiss; (4) that the line of junction is a line of fault indicated by proofs of fracture and contortion of the strata. It is true that in the course of his investigations Nicol's views underwent a process of evolution, and that even in the form in which he ultimately presented them he did not grasp the whole truth. We now know that he was in error when he regarded portions of the Archæan gneiss, occurring in the displaced masses, as igneous rocks intruded during the earth-movements, and that he failed to realise the evidence bearing on dynamic metamorphism resulting from these movements. But I do not doubt that the verdict of the impartial historian will be that Nicol displayed the qualities of a great stratigraphist in grappling with the tectonics of one of the most complicated mountain chains in Europe.

The period now under review embraces the reopening of that controversy in 1878 by Dr. Hicks, and its close in 1884 after the publication of the "Report on the Geology of the North-west of Sutherland," by the Geological Survey (NATURE, vol. xxxi. p. 29, November 1884). The Survey work has confirmed Prof. Bonney's identification of the Lewisian gneiss and Torridon Sandstone in Glen Logan, Kinlochewe (*Quart. Journ. Geol. Soc.*, vol. xxxvi. p. 93), brought into that position by a reversed fault; and Dr. Callaway's conclusions regarding overthrust faulting at Loch Broom, in Assynt and in Glencoul (*ibid.*, vol. xxxix. p. 416). Special reference must be made to the remarkable series of papers by Prof. Lapworth on "The Secret of the Highlands," in which he demonstrated the accuracy of Nicol's main conclusions, and pointed out that the stratigraphical phenomena are but the counterpart of those in the Alps, as described by Heim (*Geol. Mag.*, December 2, vol. x. pp. 120, 193, 337). His researches, moreover, led him to a departure from Prof. Nicol's views regarding the age, composition, and mode of formation of the Eastern Schists, for in the paper which he communicated to the Geologists' Association in 1884 he announced that their present foliated and mineralogical characters had been developed by the crust-movements which operated in that region since the time of the Durness quartzites and limestones (*Proc.* Geol. Assoc., vol. viii. p. 438; *Geol. Mag.*, December 3, vol. ii. 1885, p. 97). Allusion must be made also to his great paper "On the Discovery of the *Olenellus* Fauna in the Lower Cambrian Rocks of Britain," in which he not only chronicled the finding of this fauna at the top of the basal quartzite in Shropshire, but suggested the correlation of the Durness quartzites and limestones with the Cambrian rocks elsewhere (*Geol. Mag.*, December 3, vol. v. pp. 484–487). That suggestion was strikingly confirmed within three years afterwards by the discovery of the *Olenellus* fauna in Ross-shire.

The detailed mapping of the belt of Cambrian strata has proved the striking uniformity of the rock sequence. There is little variation in the lithological characters or thicknesses of the various zones. Basal quartzites, pipe-rock, Fucoid-beds, Serpulite (*Salterella*) grit, limestone, and dolomite form the invariable sequence, for a distance of a hundred miles, to the west of the line of earth-movements. This feature is also characteristic of the fossiliferous zones, for the sub-zones of the pipe-rock, the *Olenellus* fauna in the Fucoid-beds, and the *Salterella* limestone have been traced from Eriboll to Skye. Owing to the interruption of the sequence by reversed faults or thrusts, the higher fossiliferous limestone zones are never met with between Eriboll and Kishorn, but they occur in Skye, where they were first detected by Sir A. Geikie (*Quart. Journ. Geol. Soc.* vol. xliv. p. 62).

Regarding the palæontological divisions of the system, my colleague, Mr. Peach, concludes "that the presence of three species of *Olenellus* in the Fucoid-beds and Serpulite-grit of the North-west Highlands, nearly allied to the American form *Olenellus Thomsoni*—the type species of the genus—together with *Hyolithes*, *Salterella*, and other organisms found with it, prove that these beds represent the Georgian terrane of America, which, as shown by Walcott, underlies the *Paradoxides* zone." Hence he infers that there can be no doubt of the Lower Cambrian age of the beds yielding the Olenellus fauna in the North-west Highlands. Mr. Peach further confirms Salter's opinion as to the American facies of the fossils obtained from the higher fossiliferous zones of the Durness dolomite and limestone. He states that "the latter fauna is so similar to, if not identical with, that occurring in Newfoundland, Mingan Islands, and Point Levis, beneath strata yielding the *Phyllograptus* fauna of Arenig age, that the beds must be regarded as belonging to the higher divisions of the Cambrian formation."

The intrusive igneous rocks of the Assynt region, of later date than Cambrian time, and yet older than the post-Cambrian movements, have been specially studied by Mr. Teall, who has obtained results of special importance from a petrological point of view. This petrographical province embraces the plutonic complex of Cnoc na Sroine and Loch Borolan, and the numerous sills and dykes that traverse the Cambrian and Torridonian sediments, and even the underlying platform of Lewisian gneiss. He infers that the plutonic rocks have been formed by the consolidation of alkaline magmas rich in soda. At the one end of the series is the quartz-syenite of Cnoc na Sroine, and at the other the basic augite-syenite, nepheline-syenite, and borolanite. The basic varieties occur on the margin, and the acid varieties in the centre. The sills and dykes comprise two well-marked types, camptonites or vogesites, and felsites with alkali felspar and ægirine, which he believes to represent the dyke form of the magmas that gave rise to the plutonic mass (*Geol. Mag.*, December 4, vol. vii. p. 385, 1900).

The striking feature in the geology of the North-west Highlands is the evidence relating to those terrestrial movements that affected that region in post-Cambrian times, which are without a parallel in Britain. The geological structures produced by these displacements are extremely complicated, but the vast amount of evidence obtained in the course of the survey of that belt clearly proves that, though the sections vary indefinitely along the line of complication, they have certain features in common which throw much light on the tectonics of that mountain chain. Some of these features may thus be briefly summarised.

(1) By means of lateral compression or earth-creep the strata are thrown into a series of inverted folds which culminate in reversed faults or thrusts.

(2) Without incipient folding, the strata are repeated by a series of minor thrusts or reversed faults which lie at an oblique angle to the major thrust-planes and dip in the direction from which the pressure came, that is, from the east.

(3) By means of major thrusts of varying magnitude the following structures are produced: (*a*) the piled-up Cambrian strata are driven westwards along planes formed by the underlying undisturbed materials; (*b*) masses of Lewisian gneiss, Torridon Sandstone, and Cambrian rocks are made to override the underlying piled-up strata; (*c*) the Eastern Schists are driven westwards and, in some cases, overlap all major and minor thrusts till they rest directly on the undisturbed Cambrian strata.

When to these features are added the effects of normal faulting and prolonged denudation, it is possible to form some conception of the evolution of those extraordinary structures which are met with in that region. Some of the features just described occur in other mountain chains affected by terrestrial movement, as in the Alps and in Provence; but there is one which appears to be peculiar to the North-west Highlands. It is the remarkable overlap of the Moine Thrust-plane—the most easterly of the great lines of displacement. Along the southern confines of the wild and complicated region of Assynt, that plane can be traced westwards for a distance of six miles to the Knockan cliff, where the micaceous flagstones rest on the Cambrian limestone. In Durness we find an outlier of the Eastern Schists reposing on Cambrian limestone, there preserved by normal faults, at a distance of about ten miles from the mass of similar schists east of Loch Eriboll, with which it was originally continuous.

Though many of these structures appear incredible at first, it is worthy of note that some have been reproduced experimentally by Mr. Cadell (*Trans.* Roy. Soc. Edinburgh, vol. xxxv. p. 337). He took layers of sand, loam, clay, and plaster of Paris, and after the materials had set into hard brittle laminæ, in imitation of sedimentary strata, he applied horizontal pressure under varying conditions. The results, some of which may here be given, were remarkable.

(1) The compressed mass tends to find relief along a series of gently inclined thrust-planes, which dip towards the side from which pressure is exerted.

(2) After a certain amount of heaping up along a series of minor thrust-planes, the heaped-up mass tends to rise and ride forward bodily along major thrust-planes.

(3) The front portion of a mass being pushed along a thrust-plane tends to bend over and curve under the back portion.

(4) A thrust-plane below may pass into an anticline above; and a major thrust-plane above may and probably always does originate in a fold below.

Now these important experiments confirm the conclusion reached by the Geological Survey from a study of the phenomena in the field, viz., that under the influence of horizontal compression or earth-creep the rocks in that region behaved like brittle rigid bodies which snapped across, were piled up and driven westwards in successive slices. But, further, these displacements were accompanied by differential movement of the materials which resulted in the development of new structures. These phenomena culminate along the belt of rocks in immediate association with the Moine Thrust, where the outcrop of that thrust lies to the east of a broad belt of displaced materials. There, Lewisian gneiss, Torridon Sandstone, and Cambrian quartzite are sheared and rolled out, presenting new divisional planes parallel with that of the Moine Thrust. The Lewisian gneiss shades into flaser gneiss and schist, and ultimately passes into a banded rock like a platy schist. The pegmatites show fluxion structure with felspar "eyes" like that of the rhyolites. At intervals in these zones of highly sheared rocks, phacoidal masses of Lewisian gneiss appear, in which the pre-Torridonian structures are not wholly effaced. The sills of camptonite and felsite intrusive in the Cambrian rocks become schistose and together with the sediments in which they occur appear in a lenticular form. All these mylonised rocks show a characteristic striping on the divisional planes, due to orientation of the constituents in the direction of movement.

Still more important evidence in relation to the question of regional metamorphism is furnished by the Torridon Sandstone. In the case of the basal conglomerate the pebbles have been flattened and elongated, and a fine wavy structure has been developed in the matrix. In the district of Ben More, Assynt planes of schistosity, more or less parallel with the planes of the Ben More Thrust, pass downwards from the Torridon conglomerate into the underlying gneiss. Both have a common foliation irrespective of the unconformability between them. Again, along the great inversion south of Stromeferry, foliation has been developed in the Torridon conglomerate and overlying Lewisian gneiss, parallel to the plane of the Moine Thrust. The Torridon grits and sandstones south of Kinlochewe and between Kishorn and Loch Alsh are similarly affected by the post-Cambrian movements. Mr. Teall has shown that the quartz grains have been drawn out into lenticles and into thin folia that wind round "eyes" of felspar. A secondary crypto-crystalline material has been produced, sericitic mica appears in the divisional planes, and in some instances biotite is developed. In short, he concludes that in these deformed Torridonian sediments there is an approximation to the crystalline schists of the Moine type. The stratigraphical horizon of these rocks can be clearly proved. The subdivisions of the Torridon Sandstone have been recognised in those displaced masses which lie to the east of the Kishorn Thrust and to the west of the Moine Thrust. It is worthy of note also that in the belt of highly sheared gneiss south of Stromeferry that comes between the Torridonian inversion in the west and the Moine Thrust on the east, Mr. Peach has found folded and faulted inliers of the basal division of the Torridon Sandstone that have a striking resemblance to typical Moine schists.

Regarding the age of these post-Cambrian movements, it is obvious that they must be later than the Cambrian limestone and older than the Old Red Sandstone, for the basal conglomerates of the latter rest unconformably on the eastern schists and contain pebbles of basal quartzite, pipe-rock, limestone, and dolomite derived from the Cambrian rocks of the North-west Highlands.

East of the Moine Thrust or great line of displacement extending from Eriboll to Skye, we enter the wide domain of the metamorphic rocks of the Highlands, a region now under investigation, and which presents difficult problems for solution. Two prominent types of crystalline schists (Caledonian series, Callaway, and Moine schists of the Geological Survey) have been traced over wide areas in the counties of Sutherland, Ross, and Inverness, and across the Great Glen to the northern slopes of the Grampians. Consisting of granulitic quartzose schists and muscovite-biotite schist or gneiss, they appear to be of sedimentary origin, though crystalline. They are associated with recognisable masses of Lewisian gneiss covering many square miles of ground and presenting many of the structures so characteristic of that complex in the undisturbed areas already described. Within the belt of Lewisian gneiss at Glenelg Mr. Clough has mapped a series of rocks presumably of sedimentary origin, including graphitic schists, mica schists, and limestones, but the gneiss with which they are associated possesses granulitic structure like that of the adjoining Moine schists ("Summary of Progress of the Geological Survey for 1897," p. 37). Further, in the east of Sutherland, and also in the county of Ross, foliated and massive granites appear which are interleaved in the adjoining Moine schists, forming injection gneisses and producing contact metamorphism.[1]

In the Eastern Highlands the Moine series disappears and is replaced by a broad development of schists, admittedly of sedimentary origin, which have been termed the Dalradian series by Sir A. Geikie. Within recent years it has been divided into certain rock-groups which have been traced by the Geological Survey from the counties of Banff and Aberdeen to Kintyre. It has been found that, though highly crystalline in certain areas, they pass along the strike into comparatively unaltered sediments, as proved by Mr. Hill in the neighbourhood of Loch Awe ("Annual Report of the Geological Survey for 1893," p. 265). Before the planes of schistosity were developed in these Dalradian schists they were pierced by sills of basic rock (gabbro and epidiorite) and acid material (granite), both of which must have shared in the movements that affected the schists, as they merge respectively into hornblende schists and foliated granite or biotite gneiss. Both seem to have developed contact metamorphism; indeed, Mr. Barrow[2] contends that the regional metamorphism so prominent in the south-east Highlands is mainly, if not wholly, due to the intrusion of an early granite magma, now exposed at the surface in the form of local bosses of granite and isolated veins of pegmatite.

The age of the Dalradian schists has not been determined. Though there seems to be an apparent order of superposition, in this series it is still uncertain whether that implies the original sequence of deposition. Since Sir A. Geikie applied the term Dalradian to the Eastern Highland schists in 1891 (*Quart. Journ. Geol. Soc.*, vol. xlvii. p. 72), evidence has been obtained ("Annual Report of the Geological Survey for 1893," p. 266; for 1895, p. 25; for 1896, p. 27) that suggests the correlation of certain rocks along the Highland border with the Arenig and younger Silurian strata of the Southern Uplands. Consisting of epidiorite, chlorite schist, radiolarian cherts, black shales, grits, and limestone, they have been traced at intervals from Arran to Kincardineshire. In the latter region Mr. Barrow contends that they are separated by a line of disruption from the Highland schists to the north; but no such discordance has been detected in the Callander district or in Arran. Though these rocks of the Highland border have been much deformed, yet their occurrence in the same order of succession in that region and in the Southern Uplands is presumptive evidence for their correlation.

In view of this evidence it is not improbable that the Dalradian series may contain rock-groups belonging to different geological systems. Indeed, the result of recent Survey work in Islay tends to support this view. For in the south-west part of that island there is a mass of Lewisian gneiss overlaid unconformably by sedimentary strata which have been correlated with the lower and middle divisions of the Torridon Sandstone. Unfortunately the sequence ends here, as both the gneiss and overlying sediments are separated by a line of disruption or thrust-plane from the strata in the eastern part of the island. And yet, notwithstanding this break, the evidence obtained in the latter district is remarkable, whatever theory be adopted to explain it. There the Islay limestone and black slates appear to be covered unconformably by the Islay quartzite containing Annelid tubes and followed in ascending sequence by Fucoidal shales and dolomites, suggestive of the Cambrian succession in Sutherland and Ross. The Islay quartzite passes into Jura, thence to the mainland, and it may eventually prove to be the Perthshire quartzite, while the Islay limestone and black slate are supposed to be the prolongations of the limestone and slate of the Loch Awe series in Argyllshire ("Summary of Progress for 1899," p. 66).

From the foregoing data it will be seen that much uncertainty prevails regarding the age and structural relations of the metamorphic rocks of the Highlands, but the difficulties that here confront the observer are common to all areas affected by regional metamorphism.

A prominent feature in the geology of the Eastern Highlands is the great development of later plutonic rocks chiefly in the

1 "On Foliated Granites and their Relations to the Crystalline Schists in Eastern Sutherland" (*Quart. Journ. Geol. Soc.*, vol. lii. p. 633).

2 "Intrusion of Muscovite-biotite Gneiss in the South-east Highlands and its accompanying Metamorphism" (*Quart. Journ. Geol. Soc.*, vol. xlix. p. 330).

form of granite ranging along the Grampian chain from Aberdeenshire to Argyllshire. In connection with one of these masses a remarkable paper appeared in 1892 which in my opinion has profoundly influenced petrological inquiry in Scotland from the light which it threw on the relations of a connected series of petrographical types in a plutonic complex. I refer to the paper on the "Plutonic Rocks of Garabal Hill and Meall Breac," by Mr. Teall and Mr. Dakyns (*Quart. Journ. Geol. Soc.*, vol. xlviii. p. 104).

The authors showed that this plutonic mass comprises granite, tonalite, augite-diorite, picrites, serpentine, and other compounds. Mr. Teall regards the members of this sequence as products of one original magma by a process of differentiation, the peridotites being the oldest rocks, because the minerals of which they are composed are the first to form in a plutonic magma. As the process of consolidation advances, rocks of a varied composition arise, in the order of increasing acidity, viz., diorites, tonalites, and granites. The most acid rock consists of quartz and orthoclase, which may represent the mother liquor after the other constituents had separated out. Mr. Teall concludes that progressive consolidation of one reservoir gives rise to the formation of magmas of increasing acidity, and hence that basic rocks should precede the acid rocks. This theory of magmatic differentiation—so strenuously advocated by Brögger, Vogt, Rosenbusch, Iddings, Teall, and others—was first applied to the interpretation of varied types of plutonic masses in Scotland by Mr. Teall in the paper referred to. Since then he has extended its application to the granite masses in the Silurian tableland of the south of Scotland, which include rocks, ranging from hyperites at the one end to granitite with microcline, and aplite veins at the other.[1] Many of the phenomena presented by the newer granite masses of the Eastern Highlands seem to lend support to this theory. These views, indeed, have permeated the petrological descriptions of the granitic protrusions in the counties of Aberdeen and Argyll which have been given by Messrs. Barrow, Hill, Kynaston, and Craig[2] in recent years.

One of the remarkable advances in Scottish geology during the period under review is the solution of the order of succession and tectonic relations of the Silurian rocks of the south of Scotland by Prof. Lapworth. The history of research relating to that tableland, and of all his contributions to the problems connected with it, has been given in detail in the recent volume of the Geological Survey on that formation. At present it will be sufficient to refer to his three classic papers, which, in my opinion, record one of the great achievements in British geology. The first, on "The Moffat Series" (*Quart. Journ. Geol. Soc.*, vol. xxxiv. p. 240), demonstrated, by means of the vertical distribution of the graptolites, the order of succession in those fine deposits (black shales and mudstones), which were laid down near the verge of sedimentation, and are now exposed in anticlinal folds in the central belt. The second, on "The Girvan Succession" (*ibid.*, vol. xxxviii. p. 537), showed how certain graptolite zones of the Moffat shales are interleaved, in the Girvan region, with conglomerates, grits, sandstones, flagstones, mudstones, shales, and limestones, charged with all the varied forms of life found in shallow seas or near shore. In the third, on "The Ballantrae Rocks of the South of Scotland and their Place in the Upland Sequence" (*Geol. Mag.*, December 3, vol. vi. p. 20), he indicated the distribution and variation of the Moffat terrane (Upper Llandeilo to Upper Llandovery) and of the Gala terrane (Tarannon), which form the greater part of the uplands. He further pointed out how the rocks and the fossils vary across the uplands according to the conditions of deposition. Finally he proved that the complicated tectonics of the Silurian tableland, its endless overfolds, its endoclinal and exoclinal structures, can be unravelled by means of the graptolite zones. These researches disposed of the order of succession based on Barrande's doctrine of Colonies, and established the zonal value of graptolites as an index of stratigraphical horizons. So complete was the zonal method of mapping adopted by Prof. Lapworth, and so accurate were his generalisations, that few modifications have been made in his ork.

1 "Annual Report of the Geological Survey for 1896," p. 40; see also "The Silurian Rocks of Scotland" (Geological Survey Memoir, 1899, p. 607).

2 "Annual Report of the Geological Survey for 1897," p. 87; for 1898, pp. 25–28; see also paper on "Kentallenite and its Relations to other Igneous Rocks in Argyllshire" (*Quart. Journ. Geol. Soc.*, vol. lvi. p. 531).

In the course of the re-examination of the Silurian tableland by the Geological Survey some important additions were made to our knowledge of the Silurian system as there developed. Underlying all the sediments of the uplands there is a series of volcanic and plutonic rocks of Arenig age, the largest development of which occurs at Ballantrae in Ayrshire, where their igneous character was recognised by Prof. Bonney. But they appear in the cores of numerous anticlines over an area of about 1500 square miles, forming one of the most extensive volcanic areas of Palæozoic age in the British Isles. These volcanic rocks are overlain by a band of cherts and mudstones, succeeded by black shales yielding Glenkiln graptolites of Upper Llandeilo age. The cherts, which are abundantly charged with Radiolaria, implying oceanic conditions of deposition, are about 70 feet thick, and have been traced over an area of about 2000 square miles. The deposition of the Radiolarian ooze must have occupied a long lapse of time. Indeed the cherts and mudstones represent the strata which, in other regions, form the Upper Arenig and Lower Llandeilo divisions of the Silurian system. They furnish interesting evidence of the oceanic conditions which here prevailed in early Silurian time, and form a natural sequel to Prof. Lapworth's researches bearing on the graptolitic deposits of the Upper Llandeilo period, which must have been laid down on the sea-floor near the limit of the land-derived sediment.

Of special interest is the new fish fauna found by the Geological Survey in the Ludlow and Downtonian rocks between Lesmahagow and Muirkirk, which the researches of Dr. Traquair have shown to be of great biological and palæontological value (*Trans.* Roy. Soc. Edin., vol. xxxix. p. 827). This discovery has enabled him to give a new classification of the *Ostracodermi*, to enlarge the order of the ***Heterostraci***, which now includes four families, instead of the ***Pteraspidae*** alone. He has further shown that the *Coelolepidae* were not Cestraciont sharks to which the *Onchus* spines belonged, but ***Heterostraci***, though probably of Elasmobranch origin, judging from the shagreen-like scales. The *Coelolepidae* are common fishes in the Ludlow and Downtonian rocks of Lanarkshire. The genus, *Thelodus*, first described by Agassiz from detached scales in the Ludlow bone-bed, and subsequently figured and described by Pander and Rohon from scales in the Upper Silurian rocks of Oesel, is here represented for the first time by nearly complete forms. But it is remarkable that no *Onchus* spines, nor any *Pteraspidae*, nor *Cephalaspidae* have been found in the Lanarkshire strata, the nearest related genus to *Cephalaspis* being *Atelcaspis*, which, however, represents a distinct family.

The group of sandstones, conglomerates, shales, and mudstones that form the passage-beds between the Ludlow rocks and the Lower Old Red Sandstone in Lanarkshire are now regarded as the equivalents of the Downtonian strata in Shropshire, and are linked with the Silurian system. The mudstones of this group, containing the new fish fauna, likewise yield ostracods, phyllocarid crustaceans, and eurypterids—forms which connect these beds with the underlying Ludlow rocks. The band of greywacke-conglomerate, that extends from the Pentland Hills into Ayrshire, composed largely of pebbles derived from the Silurian tableland, is now taken as the base line of the Lower Old Red Sandstone on the south side of the great midland valley of Scotland.

The period under review has been marked by important additions to our knowledge of the Old Red Sandstone formation. In 1878 appeared a valuable monograph by Sir Archibald Geikie on "The Old Red Sandstone of Western Europe" (*Trans.* Roy. Soc. Edin., vol. xxviii. p. 345), by far the most important treatise on this subject since the publication of Hugh Miller's classic work published in 1841. Following up the view maintained by Fleming, Godwin-Austen, and Ramsay, that the deposits of this formation were laid down in lakes or inland seas, he defined the geographical areas of the various basins in the British area, giving to each a local name. He gave an outline of the development of the rocks north of the Grampians, in Caithness, Orkney, and Shetland. He advanced an ingenious argument in favour of correlating the Caithness flagstone series (middle division, Murchison) with the Lower Old Red Sandstone south of the Grampians. He contended that "the admitted palæontological distinctions between the two areas are probably not greater than the striking lithological differences between the strata would account for, or than the contrast between the ichthyic faunas of adjacent but disconnected water basins at the present time." Sir A. Geikie further gave a table showing the vertical range of the known fossils of the Caithness series from data partly supplied by the late Mr. C. Peach.

During the last quarter of a century Dr. Traquair has made a special study of the ichthyology of the Old Red Sandstone and Carboniferous strata of Scotland, which has enabled him to throw much light on the distribution of fossil fishes in these rocks and on their value for the purpose of correlation. His researches show that the fish fauna of the formation south of the Grampians resembles that of the Lower Old Red Sandstone of the West of England and adjoining part of Wales in the abundance of specimens of *Cephalaspis*, the common species in Forfarshire (*C. Lyelli*, Ag.) being also indistinguishable from that in the Herefordshire beds. *Pteraspis* occurs in both regions, though of different species. Of Acanthodians *Parexus recurvus*, Ag., occurs in both, together with *Climatius* (*C. ornatus*, Ag.). The abundance of *Cephalaspis* (*C. Campbelltonensis*, Whit., *C. Jexi*, Traq.) and of *Climatius* spines is characteristic of the Lower Devonian rocks of Canada.

The Old Red Sandstone of Lorne has recently yielded organic remains, akin to those found in Forfarshire, south of the Grampians, viz., *Cephalaspis Lornensis*, Traq., two species of myriapods (*Campecaris Forfarensis* and a species of *Archidesmus* ("Summary of Progress, Geological Survey, 1897," p. 83).

In the deposits of Lake Orcadie, north of the Grampians, quite a different fish fauna from that of Forfarshire appears. Dr. Traquair has noted that there are no species common to the two areas, and only two genera, viz., *Mesacanthus* and *Cephalaspis*. The latter genus is, however, represented in Caithness only by a single specimen of a species (*C. magnifica*, Traq.) different from any found elsewhere. It might here be observed that *Cephalaspis* is represented also in the Upper Devonian rocks of Canada by a single specimen of a peculiar species (*C. laticeps*, Traq.), and hence Dr. Traquair has shown that, though *Cephalaspis* is most abundant in the Lower Devonian, it extends also into the upper division of that system. It further appears that *Osteolepidae* (*Osteolepis*, *Diplopterus*), *Rhizodontidae* (*Tristichopterus*, *Gyroptychius*), *Holoptychiidae* (*Glytolepis*), *Asterolepidae* (*Pterichthys*, *Microbrachius*), *Ctenodontidae* (*Dipterus*) are abundant in the Orcadian fauna, none of which has occurred in the Lower Old Red Sandstone of Forfarshire, the West of England, or in the Lower Devonian rocks of Canada. Dr. Traquair recognised, however, the identity of the fishes from the well-known fish band in the basin of the Moray Firth with those brought from the west part of Orkney, though these forms did not quite agree with the fossils from the Thurso district. He subsequently found that the fish fauna from the Orcadian beds in the Moray Firth basin is represented in Caithness by that of Achanarras; and, further, that two other faunas occur in the Caithness area—that of Thurso and that of John o' Groats as given below:—

John o' Groats...	*Tristichopterus alatus*, Egert.
	Microbrachius Dicki, Traq.
Thurso ...	*Coccosteus minor*, H. Miller.
	Thursius pholidotus, Traq.
	Osteolepis microlepidotus, Pander.
Achanarras ...	*Pterichthys*, 3 species.
	Cheirolepis Traillі, Ag.
	Osteolepis macrolepidotus, Ag.

In 1898 appeared an important paper by Dr. Flett on "The Old Red Sandstone of the Orkneys" (*Trans.* Roy. Soc. Edin., vol. xxxix. p. 383), in which he described the results of his detailed examination of the islands. He proved the existence there of three fish faunas, and their correspondence with those identified in Caithness by Dr. Traquair. From the evidence in the field he adopted the following order of succession and correlation of the strata:—

3. Eday Sandstones and John o' Groats beds.
2. Rousay and Thurso beds.
1. Stromness, Achanarras, and Cromarty beds.

A further important result of Dr. Flett's researches in the Old Red Sandstone of these northern isles was communicated to the Royal Society of Edinburgh this year. He has found in the Shetland beds, which had previously yielded no fossils save plants, fragments, identified by Dr. Traquair as *Holonema*, a fish new to Britain, but occurring in the Chemung group of North America, the subdivision of the Upper Devonian that immediately underlies the Catskill red sandstones, with remains of *Holoptychius*. Dr. Traquair has also recognised in Dr. Flett's collection fragments of *Asterolepis*, a genus characteristic of the Upper Old Red Sandstone, and which, as proved by Dr. Flett, occurs in the "Thurso beds" of the Orkneys. The interest attaching to this discovery is very great, for Dr. Flett contends that it indicates a fourth life-zone in the Orcadian series, and, further, that it tends to span the break between the Orcadian division and Upper Old Red Sandstone.

In the Upper Old Red Sandstone on the south side of the Moray Firth, Dr. Traquair recognised two life-zones, and subsequently, with the assistance of Mr. Taylor, Lhanbryde, a third, in the following order. The lowest is that of the Nairn sandstones with *Asterolepis maxima*, Ag.; the second, that of Alves and Scaat Craig with *Bothriolepis major*, Ag., *Psammosteus Taylori*, Traq.; and the highest that of Rosebrae, the fauna of which, according to Dr. Traquair, has a striking resemblance to the assemblage in the Dura Den Sandstones in Fife.

Before 1876 all the Carboniferous areas in the great midland valley of Scotland had been mapped by the Geological Survey. The extent and structural relations of the various coal-fields were determined according to the information then available, and shown in the published maps. But the rapid development of certain fields in the east of Scotland necessitated a revision of them which has lately been done. The Fife coal-field has been re-examined by Sir A. Geikie, Mr. Peach and Mr. Wilson, and the oil-shale fields in the Lothians have been mapped by Mr. Cadell. An important memoir by Sir A. Geikie on "The Geology of Central and Western Fife and Kinross" has just been issued by the Geological Survey, in which the structure of these coal-fields is described. Mr. Cadell lately gave an account of the geological structure of the oil-shale fields in his presidential address to the Edinburgh Geological Society.

Within the period under review detailed researches of great importance on the fossil flora of British Carboniferous rocks have been carried out by Mr. Kidston, to which reference ought to be made. The results are of the highest value for correlating the strata in different areas.[1] By means of the plants he arranges the Carboniferous rocks of Scotland in two great divisions: a lower, comprising the Calciferous Sandstone and Carboniferous Limestone series; and an upper, including the Millstone Grit and the Coal-measures, there being a marked palæontological break at the base of the Millstone Grit. He shows that the upper and lower divisions of the system, not only in Scotland but in Britain, are characterised by a different series of plants, not one species passing from the lower division—save in the case of *Stigmaria*—into the upper. From his researches it appears that, among ferns, *Neuropteris* is all but unknown in the lower division, whereas in the upper it is very abundant. The *Sphenopterids* are proportionately common in both divisions; but those of the lower are usually characterised by cuneate segments, while those of the upper have generally rounded pinnules. *Alethopteris*, so common throughout the whole of the upper series, is entirely absent from the lower. The genus *Calamites*, which is extremely plentiful in the upper, is almost entirely absent from the lower division, where its place is taken by *Asterocalamites*. The *Cordaiteae* are also rare below the Millstone Grit, though very plentiful above that horizon. *Sigillaria*, so rare in the Lower Carboniferous rocks, is extremely abundant in the upper division, and particularly in the middle Coal-measures. In short, Mr. Kidston concludes that the floras of the two main divisions of the Carboniferous system, though belonging to the same types, are absolutely distinct in species, and in the relative importance of the genera.

By means of the fossil plants Mr. Kidston correlates the Coal-measures of Scotland underlying the red sandstones with the lower division of the Coal-measures of England, and the overlying red sandstones of Fife with the middle division of the English Coal-measures.

It is remarkable that the evidence supplied by the fossil fishes has led Dr. Traquair independently to a similar conclusion. He holds that fossil ichthyology proves the existence of only two great life-zones in the Carboniferous rocks of Central Scotland—an upper and a lower—the boundary line between the two being drawn at the base of the Millstone Grit. The Scottish Carboniferous rocks, being mostly estuarine, give an opportunity of comparing the estuarine fishes of both divisions. He finds the Coal-measure fishes of Scotland to be the same as those in the English Coal-measures, while those occurring below the

[1] "On the Various Divisions of British Carboniferous Rocks as determined by their Fossil Flora," *Proc.* Roy. Phys. Soc. Edin., vol. xii. p. 183 1893).

Millstone Grit in Scotland are mostly different in species, and often, too, in genera, from the forms above that horizon.

Of special interest as bearing on the former extension of this system in Scotland is the discovery made by Prof. Judd (*Quart. Journ. Geol. Soc.*, vol. xxxiv. p. 685) in 1877 of a patch of Carboniferous sandstones and shales, with well-preserved plant remains in Morven. Another small outlier of this formation has recently been found in the Pass of Brander by the Geological Survey ("Summary of Progress, Geological Survey," 1898, p. 129).

The reptiles from the Elgin sandstones, recently described by Mr. E. T. Newton (*Phil. Trans.*, vol. clxxxiv. 1893, p. 431); *ibid.*, vol. clxxxv., 1894, p. 573), add fresh interest to the study of these rocks. The structural relations of these sandstones have been fully treated by Prof. Judd in his great paper on the Secondary Rocks on the east of Scotland (*Quart. Journ. Geol. Soc.*, vol. xxix. p. 98), and again in his presidential address to this Section at Aberdeen (*Rep. Brit. Assoc.* for 1885, p. 994), who confirmed Huxley's well-known correlation of these beds with the Trias. The Dicynodont skull, identified by Prof. Judd and Dr. Traquair at the Aberdeen meeting of the British Association in 1885, and other remains found in the reptilian sandstones in Cutties Hillock Quarry, where they rest on Upper Old Red Sandstone with *Holoptychius*, have been described by Mr. Newton. He confirmed their affinity with Dicynodonts, though they were referred to the genera *Gordonia* and *Geikia*. But the most remarkable specimen was the skull named by Mr. Newton *Elginia mirabilis*. This extraordinary creature, with a pair of horns projecting like those of a short-horned ox, and with smaller spines and bosses, numbering thirty-nine, is related to the great *Pareiasaurus* from the Karoo beds of South Africa. Two other reptiles are described by Mr. Newton from this quarry, namely, a small crocodile-like animal, *Erpetosuchus Granti*—apparently nearly allied to *Stagonolepis*—and *Ornithosuchus Woodwardi*, which is probably a small Dinosaurian.

Mr. Newton has raised an interesting point in connection with his researches. He calls attention to the fact that the reptilian remains from the Cutties Hillock Quarry differ from those found at other localities in the Elgin district. For example, the Lossiemouth sandstones have yielded *Stagonolepis*, *Hyperodapedon* and *Telerpeton*; and the Cutties Hillock sandstones, the Dicynodonts (*Gordonia* and *Geikia*), the horned reptile (*Elginia*), the small crocodile-like *Erpetosuchus*, and the little Dinosaurian *Ornithosuchus*. Does this distribution indicate different stratigraphical horizons? is virtually the point raised by Mr. Newton. In connection with this inquiry he cites the evidence obtained in other countries. Thus, in the Gondwana beds of India, the series of reptiles similar to those of Elgin occur at different localities and on different stratigraphical horizons; *Dicynodonts* and *Labyrinthodonts* being found in the lower Panchet rocks, while *Hyperodapedon* and *Parasuchus* (allied to *Stagonolepis*) are met with in the higher Kota-Maleri beds. Again in the Karoo beds of South Africa the *Dicynodonts* and the great *Pareiasaurus*—the latter being the nearest known ally of the horned reptile (*Elginia mirabilis*) from Cutties Hillock, Elgin—occur low down in that formation. Further light is thrown on the question by the interesting discoveries of Amalitzky in Northern Russia, where a number of reptilian remains have been found closely allied to *Pareiasaurus*, *Elginia* and *Dicynodon*, in beds, which are referred to the Permian formation and accompanied by plants and mollusca which seemingly confirm this reference.[1]

In view of these foreign discoveries Mr. Newton concludes that the Elgin sandstones may probably represent more than one reptilian horizon, and that we are confronted with the possibility of their being of Permian age.

The difficulty of drawing a boundary line between the Trias and the Upper Old Red Sandstone of Elgin, which impressed the mind of the late Dr. Gordon, has had to be faced elsewhere in Scotland. In Arran, my colleague, Mr. Gunn, has shown that the Trias there rests on Upper Old Red Sandstone, both formations having a similar inclination. Even he, with his ripe experience, has had great difficulty in drawing a boundary between them on the west side of the island; but when the base line of the Trias is traced eastwards to Brodick it passes transgressively on to Carboniferous rocks.

Of special importance is the recent discovery in Arran of the fossils of the *Avicula contorta* zone ("Summary of Progress, Geological Survey, 1899," p. 133) by Mr. Macconochie, of the Geological Survey, to whose skill as a fossil collector Scottish geology owes much. With these occur Lower Liassic fossils, in sediments which are not now found in place in the island. These fossiliferous patches are associated with fragmental volcanic materials filling a great vent, the age of which will be referred to presently. This discovery has fixed the Triassic age of the red sandstones and marls in the south of Arran. The detailed mapping of the island by Mr. Gunn has demonstrated that the Triassic sandstones rest partly on the Old Red Sandstone, partly on the Carboniferous Limestone Series and partly on the Coal-measures.

In 1878 appeared the third of Prof. Judd's great papers on the Secondary Rocks of Scotland, wherein he unravelled the history of these strata as developed in the east of Scotland and in the West Highlands. His admirable researches, in continuation of the work done by Bryce, Tate and others embraced the identification of the life-zones, their correlation with those of other regions, the history of the physical conditions which prevailed in Scotland during Mesozoic time, and the working out of the structural relations of the strata (*Quart. Journ. Geol. Soc.*, vol. xxix. p. 97, vol. xxxiv. p. 660). He showed that their preservation on the east of Scotland was due to the existence of great faults, and those in the West Highlands to the copious outpouring of the Tertiary lavas. He was the first to detect the occurrence of Cretaceous rocks in the West Highlands, and to show the marked unconformability which separates them from the Jurassic strata. His main life-zones and his main conclusions regarding the Secondary Rocks of Scotland have so far been confirmed by the detailed mapping of the Geological Survey. An interesting addition to our knowledge of these rocks was made by my colleague, Mr. Woodward, in the course of his field work, who found the oolitic iron ore in the Middle Lias of Raasay, the position of which corresponds approximately with that of the Cleveland ironstone (*Geol. Mag.*, December 3, vol. x. p. 493 (1893).

The extensive plateau of Tertiary volcanic rocks in the Inner Hebrides has been a favourite field of research ever since the time of Macculloch, the great pioneer in West Highland geology. During the period under review much work has been done in that domain. According to Prof. Judd, that region contains the relics of five great extinct volcanoes and several minor cones, indicating three periods of igneous activity. The first was characterised by the discharge of acid lavas and ashes, the molten material consolidating down below as granite; the second by the outburst of basic lavas, now forming the basaltic plateau, connected with deep-seated masses that appear now as gabbro and dolerite; the third by the appearance of sporadic cones, from which issued minor streams of lava (*Quart. Journ. Geol. Soc.*, vol. xxx. p. 220).

In 1888 Sir A. Geikie communicated his elaborate monograph on the history of Tertiary volcanic action in Britain to the Royal Society of Edinburgh (*Trans.* Roy. Soc. Edin., vol. xxxv., part 2, p. 23), which has been incorporated, with fuller details, in his recent work on "The Ancient Volcanoes of Great Britain." His main conclusions may thus be briefly stated: (1) The great basaltic plateaux did not emanate from central volcanoes, but are probably due to fissure eruptions; (2) the basaltic lavas were subsequently pierced by laccolitic masses of gabbro, which produced a certain amount of contact alteration on the previously erupted lavas; (3) the protrusion of masses of granophyre and other acid materials by means of which the basic rocks were disrupted.

During the last six years Mr. Harker has been engaged in mapping the central part of the isle of Skye, and in the petrographical study of the rocks, the results of which have been summarised in the annual reports of the Geological Survey. As regards the basaltic lavas, he finds that while they have been of vast extent the individual flows have been of feeble volume, and show no evident relation to definite centres of eruption. There were two local episodes, however, which took the form of central eruptions: one represented by a number of explosive outbursts at certain points; the other, in the basalt succession, gave rise to rhyolitic rocks.

Mr. Harker further finds that the succeeding plutonic phase of activity, confined in Skye to what is now the central mountain tract, is represented by three groups of plutonic intrusions, in the following order: peridotites, gabbros and granites. The metamorphism set up in the basaltic lavas near the large plutonic masses presents points of interest, especially the

[1] Y. Amalitzky, "Sur les fouilles de 1899 de débris de vertébrés dans les dépôts Permiens de la Russie du nord." (Varsovie, 1900.)

widespread formation of new lime-soda-felspars from the zeolites in the lavas.

After the intrusion of the granite of the Red Hills, Mr. Harker finds that igneous activity took the form of intrusions of smaller volume, but in some cases of wide distribution. The great group of dolerite sills belongs to this period. An enormous number of acid and basic dykes followed, of several distinct epochs. A set of minor basic intrusions of quite late date is found in the gabbro district of the Cuillins, the most interesting of which takes the form of sheets of dolerite, parallel at any given locality, but always dipping towards the centre of the gabbro area. Mr. Harker considers that this remarkable system of injections presents a new problem in the mechanics of igneous intrusion. The latest phase of vulcanicity in the Cuillin district is a radial group of peridotite dykes. As regards the local group of rock in Central Skye Mr. Harker finds that the order of increasing acidity which ruled in the plutonic phase was reversed for the minor intrusions which followed.

In connection with the great development of volcanic activity in the West of Scotland in Tertiary time reference must be made to the remarkable volcanic vent in Arran the recognition of which is due to the suggestion of my friend Mr. Peach. This volcanic centre covers an area of about eight square miles, and lies to the south of the granite area of the island (*Quart. Journ. Geol. Soc.*, vol. lvii. p. 226 (1901). The vent is now filled with volcanic agglomerate and large masses of sedimentary material, some of which have yielded the Rhætic and Lower Lias fossils already referred to, the whole being pierced by acid and basic igneous rocks. One of the interesting features connected with it is the occurrence of fragments of limestone with the agglomerate, which has yielded fossils of the age of the chalk, thus proving that the vent is post-Cretaceous. There is thus strong evidence for referring the granite mass in the north of the island and most of the intrusive, acid, and basic igneous rocks to the Tertiary period. It furnishes remarkable proof of the suggestion of the Tertiary age of the Arran granite made by Sir A. Geikie in 1873 (*Trans.* Geol. Soc. Edin., vol. ii. p. 305). The story unfolded by this discovery is like a geological romance. The former extension of Rhætic and Lower Lias strata and of the chalk in the basin of the Clyde, and the evidence of extensive denudation in the south of Scotland, appeal vividly to the imagination.

This outline of the researches in the solid geology of Scotland would be incomplete without reference to the publication of Sir A. Geikie's great work on "The Ancient Volcanoes of Great Britain" (1897), in which the history is given of volcanic action in Scotland from the earliest geological periods down to Tertiary time. To investigators it has proved invaluable for reference. Nor can I omit to mention the new edition of his volume on "The Scenery of Scotland," wherein he depicts the evolution of the topography of the country with increasing force and fascination. In this domain it may be said of the author, "Nihil tetigit, quod non ornavit."

From the brief and imperfect sketch which I have tried to give of recent advances in the solid geology of Scotland it will be admitted that restless activity and progress have been characteristic of the last quarter of a century. But we may expect that the conclusions accepted now will be rigorously tested by our successors, probably in the light of new discoveries and with more perfect methods of research. It is well that it should be so, for thereby our branch of science advances. Meanwhile, as we look back on the phalanx of geologists that Scotland has produced—to Hutton and Hall, Murchison and Lyell, Hugh Miller and Fleming, Nicol and Ramsay—and reflect on the services which they rendered to geology, we may hope that this record of progress may prove a fitting sequel to the labours of these illustrious men.

SECTION G.

MECHANICS.

OPENING ADDRESS BY COLONEL R. E. CROMPTON, M.INST.C.E., PRESIDENT OF THE SECTION.

AT this the first meeting of the British Association of the new century I wish to lay before you some of the interesting problems presented by recent developments in means of locomotion on land which demand the best thoughts, not only of our engineers, but of everyone interested in the improvement in means of travelling and in the more rapid transit of goods.

During the seventy years which have passed since the introduction of railways in almost every country, passenger and goods traffic has developed itself to such an extent that almost everyone is interested in these questions; and of late years our attention has not been confined to railways only, but, owing to the invention of the cycle and motor-car, has also been directed to travel on our road-ways, which during the first fifty years of the railway era had somewhat fallen into disuse. I am not able, being limited to the length of this address, to deal with many of the interesting questions affecting our long-distance railways other than by referring to the probable early introduction of railways of a new type intended to attain a speed of 120 miles per hour and worked by electrical power. The railway race to Scotland of a few years back attracted the attention of the managers of American and Continental railways to railway speed questions, and we have seen during the last few years so great improvement in the speed of the trains and the comfort of the passengers in these countries that it appears that England has already been beaten in the matter of extreme railway speed, although it is probable that our railways still provide a larger number of rapid trains than either the American, German, or French do. But whether it be in England or in the countries I have mentioned, it appears that after all the speed limit of railways of the present system of construction is reached at about sixty-five or seventy miles per hour. Higher speed on level runs has undoubtedly been recorded, but it is not probable that anything greatly in excess of seventy miles per hour will be reached until our railway managers initiate an entirely new system of construction. The high-speed service that is now in contemplation, not only in England but in America and Germany, intends to attain speeds of more than one hundred miles per hour by providing electrical means of haulage sufficient to propel light trains consisting of one, or, at the most, a few cars; and in order to render this service successful to run these light trains at short intervals of time, so in effecting this high speed the railways will give a service which more nearly resembles the tramway service than our present system of heavy express trains at infrequent intervals. This high-speed service of light trains at frequent intervals is well suited to electrical haulage, as it works generating machinery situated at fixed points to the best advantage and enables the best return to be obtained from the necessarily heavy capital cost of copper in the conductors which transmit the energy along the length of the line, as it is evident that if the speed be sufficient to ensure that each section of the line only carries one running train, the costs of the conductors will be in proportion to the weight of that train.

Great advantages have already been made in adapting electrical traction to long lengths of railways. The work already done by Brown Boveri, of Baden, in Switzerland, at first on the mountain railways and afterwards on the Burghdorf-Thun full-gauge line, the experimental work of Ganz and Co., of Buda-Pesth, and of Siemens and Halske at Charlottenburg, have already shown that the power problems are nearly all of them solved, so that we may feel confident that electrical engineers will very shortly surmount any power difficulties that still remain. But this high-speed railways problem at present presents certain unknown factors which can only be satisfactorily determined by the actual testing and working the lines when carrying passengers. I refer to those which deal with the increased oscillation, vibration, and noise to be expected from the extreme speeds. These matters must be met so as to give sufficient comfort and protection to the passengers, for if passengers are rendered uncomfortable by the extreme speed the service can never become popular, and on this last question depends the most important question of all, viz. the extent to which the travelling public are likely to make use of a high-speed railway service. In attempting to forecast this matter, although we meet many business men who think it would be an undoubted advantage if the journeys between important business centres occupied half the time they do at present, in the United Kingdom there are only a few journeys of sufficient length to make saving of time of great importance, but the case is far different in America and on the Continent, where the business centres are much further apart than they are here. I, as an English engineer, foresee that this topographical question will cause our English engineers to be at a disadvantage as compared with American and Continental ones, for it appears likely that the number and mileage of high-speed railways is likely to be far greater in America and on the Continent than in the United Kingdom. Before I entirely leave the subject of very high-speed railways, a rather curious speculation presents itself to us: this is whether the need for rapid communication between town and town may not eventually be supplied by high-speed motor-cars on roads specially prepared for them. Mr. Wells in his interesting forecast in the *Fortnightly Review* seems to think that the time is not far distant when all passenger traffic will be carried on special roads on motor-cars. That the advantages of carrying your family and loading up your belongings at your own door, in your own or a hired car, and transporting them without any change or handling of your baggage right up to the point where your journey ends, will be so great that even for comparative long journeys travellers will prefer it to the railway, and that our railways will eventually be relegated to carrying minerals and heavy goods. But, without going so far as Mr. Wells, it does seem probable that if only a few passengers require to travel between two business centres such as Manchester and Liverpool, and to occupy only half the time from door to door at present taken by the railway and the two terminal cab rides, it might be better to provide one of Mr. Wells' improved roads on which private owners could run their own cars, paying toll for the road, and on which a public service of cars would provide for those who did not own cars themselves.

I now propose to deal at somewhat greater length with what I think is a most important problem in locomotion, viz. that caused by the congestion of street traffic in our towns and by the undoubted difficulties which exist in carrying our workers to and from their homes in the country to their places of employment in our towns. A large proportion of the workers who during the latter half of the last century lived and worked in the country are now working in towns, although some of them still live outside in order to obtain the advantages of lower rents and of a healthier life for their families, and this last class is likely to increase largely. Those who have been responsible for the enlarging and improvements of our towns have done so much to make town life preferable to country life that the country is gradually being depopulated. The results we see in the increasing difficulties which the town authorities find in dealing with the water and sewerage questions, and in the increasing mass of vehicular street traffic, which makes some of our cities veritable pandemoniums. Luckily it seems that we are likely through the skill and energy of our engineers to meet these difficulties in more than one way. The cycle, which commenced as an amusement and went on as a fashionable craze, has now settled down into being the poor man's horse. The number of our working population that use the cycle for going to and from their work is already very large and is steadily increasing, and their use of the roads must be considered. Then came the motor-car, developed in France to such an amazing extent, and which seems now likely to be developed to an equal extent in this country. After many years of objecting to the use of the overhead trolley system, our town authorities seem now to have determined that the only way of relieving street traffic is by an enormous development of electrical tramways, and on all sides we find the large towns rivalling one another in the extent of the tramway systems which they have either acquired or are laying down for themselves. It seems opportune now to point out that a great deal of mischief may accrue by this indiscriminate use of tramways, and for those who are considering these matters I bring forward a few facts which are worthy of notice. Of course, in new countries, or in new towns in old countries, where the roads are rough and bad, anything in the nature of a tramway using rails is an improvement on a roadway; but when we are dealing with cities which already possess well laid out and well paved streets on which all kinds of wheel traffic can be carried on with a minimum of rolling resistance, it seems wrong from an engineering point of view to break up the surface of these streets for the purpose of laying tramways, and for the following important reasons: Traffic carried on a roadway by vehicles, whether horse-drawn or by cycle or motor-car, differs from traffic carried on rails chiefly in that the former vehicles possess an important power, viz. that of *overtaking*, which is not possessed by the latter, that is to say that vehicles on the plain road surface can overtake a stopping or a slower vehicle going in the same direction without interfering with other vehicles, whereas on rails the vehicles going one way must always remain in the same relation to one another, so that the speed of vehicles on rails must always be regulated by that of other vehicles going in the same direction. Street tramways, for instance, must stop to set down and take up passengers: this limits the speed average and the number of vehicles per mile of track, for if there be not sufficient intervals between the vehicles they would have to stop and start nearly simultaneously. Thus the carrying capacity of the best modern electrical tramway is limited by this want of overtaking power. I have made careful inquiry from those who have great experience in tramways not only in this country but in America and on the Continent, and I find that it is generally admitted that the maximum carrying capacity of an electrical tramway in one direction is 4000 passengers per hour carried past any given point. I find that a full-gauge suburban or metropolitan railway crowded to its fullest extent cannot carry more than 12,000 passengers per hour. Now most of us have often seen large crowds taken away from a point of attraction by omnibuses and horse-drawn vehicles, and have noticed that the crowded omnibuses almost touch one another and yet can go at a fair rate of speed. In this case at eight miles per hour speed 14,000 passengers can be carried from a given point per hour.

Up to the present a public motor-car service has not yet been installed of any magnitude to enable us to compare the carrying capacity of motor-cars with that of horse-drawn omnibuses, but owing to the reduced length of motor-cars compared with that of omnibuses, and on account of their greater speed and greater control, motor-cars can now be built to deal with great crowds at an even higher rate per hour than that noted above. It appears certain, therefore, that although the provision of electrical tramways is undoubtedly an economical means of carrying passengers, yet that these tramways cannot be laid in existing thoroughfares without considerably reducing the total road carrying capacity at times of heavy pressure of traffic, and as it appears likely that either for the daily transport of the workers to and from their homes to places of employment, or for taking great crowds out into the country for pleasure purposes, a motor-car service carried out on well-made roads will compete favourably with, and in many ways may be preferable to, tramway service.

It must be remembered that the laying of tram rails not only blocks ordinary traffic, but in our most crowded streets it introduces dangers to all wheeled vehicles not on rails, motor-cars, and cyclists by the skidding of the wheels when they cross the line of rails, and these dangers are daily causing, and are still likely to cause, very serious accidents.

The increased road and street traffic and the development of new means of road locomotion have made imperative some modification of our existing system of roadway administration. Cycles, motor-cars, electrical tramcars, have been invented and put on roads which are maintained and worked exactly as they were seventy years ago at the commencement of the railway era, when the population of the United Kingdom was half its present figure, and that of the large towns one-tenth of the present figure. During the 150 years previous to the railway era the ancient tracks were gradually improved into tolerably efficient roads for coach and wagon traffic, but after the introduction of railways there was a complete cessation of improvement, as for fifty years after the railways started the old roads were equal to the farmers' and local traffic which the railways left for them; but for the last twenty years the roads near to the great towns have been inadequate, and now that the cyclist and motor-carist travel over the whole of the roads of the country the neglect of our ancient roadway system is very apparent.

Although the urban populations have so greatly increased, the old coaching roads are still the only ones that exist; no main roads parallel to the old ones or alternative to them have ever been made. Towns which are now joined by railways grew out of small rows of houses built facing the main road; in fact, in many cases the road made the town. During the early part of the railway era, when the roads were so little used from coaching falling into disuse, encroachments on the roadway took place in and near the towns, such roads being now actually narrower and less suitable for traffic than in the coaching days: so that these towns which owe their existence to these roadways now put every impediment and hindrance to their use by the travelling public. What is needed is that towns situated on our main through roads should provide alternative routes, so that through travellers could, if they desired, avoid the crowded streets of the town. One method of providing such relief roads would be by by-laws providing that all building estates should set aside land for main roads. The building estates which are developed around our great towns never provide a road which can be used as a main line of thoroughfare, although by their very act of building additional houses they cause additional congestion to the main roads. They lay out their roads to obtain quiet for those who live on the estate, and take every possible means to prevent their estate roads from taking a share of the main thoroughfare traffic.

Parliament must take in hand an improved administration of our highways by a comprehensive scheme. Far too many ancient main lines of thoroughfare, already too narrow for the traffic which is on them, are being blocked by having tramways laid on them; these cause the development of building estates, which throw additional traffic on to these thoroughfares. Apart from the roads themselves, the complicated conditions of street and road traffic demand careful regulation. Street traffic should be carried so far as possible by lines of vehicles driven as nearly parallel to one another as possible. The rule of the road, as it is called, and which is embodied in an Act of Parliament, 5 and 6 of William IV., which is commonly called the Highways Act, says that every vehicle is to keep as close as possible to the left, or near side of the road, except when overtaking another vehicle going in the same direction, and then it is to keep to the off side of the overtaken vehicle as closely as possible. As a matter of fact, everybody knows that this rule is habitually neglected by drivers who, whenever they get a chance, drive down the centre of the road, so that others who overtake them dare not do so on the wrong or near side, but must pass out far to the off side of the road, and consequently interfere with the traffic coming in the opposite direction. This neglect of the rule of the road causes a great waste of space immediately behind every vehicle, and is one of the chief causes of the limited carrying capacity of the streets in cities where the police do not attend to this important matter. It can be remedied by the existing police regulations being adhered to and insisted on by fixed-point constables, or by constables moving about on motor-cars or bicycles. Slow moving and frequently stopping vehicles are another cause of congested traffic. A great deal might be done by arranging that during certain hours much of the slower moving traffic is shunted into alternative routes, so as to be kept by itself. An increase in the speed of the street traffic is desirable; for the faster the vehicles travel the less the street is occupied by them. Motor-cars can safely travel at sixteen miles an hour, and, therefore, need only take half the time and occupy only half the street surface that an omnibus does when travelling at eight miles per hour. Such high speeds as these, which are desirable and perfectly safe for motor cars, cannot, however, be obtained unless some regulations are made as to the use of the roadways by foot passengers. There is no rule of the road for foot passengers—they pass one another on the footpath, or vehicles in the roadway, just as they please. No driver of a vehicle in the road who sees a foot passenger stepping into the roadway can ever tell with certainty what his movements will be. It will be no hardship to foot passengers to insist on their movements being regulated.

Much has been recently said and written on the subject of motor-cars and motor-wagons. It is generally admitted that there will be considerable scope for engineering skill and capital in their improvement and construction. It is by no means an easy problem to put into the hands of the public such a complicated piece of mechanism as a self-propelled carriage which has in most cases to be managed and driven by men who have had no special mechanical training. Motor-cars to be universally successful must be made so as to reduce to a minimum the liability to break down; repairs must be limited to the replacement of worn or damaged parts by other parts, which must be supplied by the manufacturers so that they can be readily put in by the unskilled users. That this can be done is shown by the success and universal use of typewriters, sewing machines, and bicycles: all of these are really complicated pieces of mechanism, but which are now in such general use and in everyone's hands. In these cases, however, the organised manufacture of machines with thoroughly interchangeable parts, or components as it is the fashion to call them, has only been developed after the type of machine had settled down, and this up to the present cannot be said of the motor-car or motor-wagon. Up to the present the development of these cars has gone on on several lines. The development in France, which so far has led the world, has been principally in the direction of the use of light motors driven by petrol spirit. Again to France we owe the flash boiler of Serpollet, which assists the use of steam engines for this purpose.

At first sight steam, with the complications of boiler, engine, and condenser, does not appear likely to compete favourably with the simpler spirit motor, but for heavier vehicles, where steady heavy pulling power is of importance, up to the present no internal combustion motor has competed with it. The Americans, with their usual skill and power of rapidly organising a new manufacture, have already turned out a very large number of steam-driven motor-cars, which are so largely in use in unskilled hands that it shows that they have already solved the problem to some extent.

The directions in which the two classes of motors require further development are, for the internal combustion motors, the satisfactory and inodorous use of the heavier oils, and in this perhaps Herr Diesel may help us with his wonderfully economical motor improvements in the clutch mechanism, for with all internal combustion engines up to the present it has been found impossible to start the motor when coupled to the driving-wheels of the car; and in the case of the steam motor the simplification of the boiler, the boiler feed mechanism, the inodorous and noiseless burning of heavy oils as fuel, improved condensers, methods of lubricating the pistons and valves so as to avoid oil passing back to the boiler with the condensed water, and the rendering of all processes of boiler feed and fuel feed mechanism completely automatic so as not to require the attention of the driver. On points common to both classes, although much has been done, further improvement is required in the methods of transmitting the power from the motor to the driving-wheels. In the case of the steam cars, where this has been done by single reduction, using chain, pinion, and sprockets, very efficient and noiseless transmission has already been obtained, but up to the present in most of the internal combustion engines where more than two cylinders have to be employed, it has been found necessary to arrange the crank shaft of the motor at right angles to the axle of the driving-wheels, so that part of the transmission having to be through bevel gear, this part has up to the present always been noisy. In the providing of noiseless and efficient chain driving, the manufacturer of cars has gained greatly by the high degree of perfection to which these chains had already attained for bicycle work.

The recent great road races which have taken place in France and elsewhere have shown that the motor-car can be driven safely at a very high speed, already reaching in some cases seventy miles an hour; but to render this capacity for high speed useful, not only must special roads be provided on which these high-speed cars can travel without danger to others and with least slip and wear and tear of tyres, but a great deal requires to be done in the improvement of the pneumatic tyres, which at present get excessively hot, and therefore damaged by these high-speed runs. At these high speeds the mechanical work done on the material of which the outer covers of pneumatic tyres are composed is excessively high. It can probably be reduced by increasing the diameter of the wheels, but, of course, at the cost of increased weight and, to some extent, of stability, for the side strains on the wheels of these cars when swinging round curves of sharp radius are very great.

Another direction in which mechanical invention is required for the wheels of motor cars and wagons is a shoeing or protection of hard material of easily renewable character which can be firmly and safely attached to the outside of the tyre covers to take the wear and cutting action caused by the driving strain and by the action of the breaks on sudden stops.

The late R. W. Thomson, of Edinburgh, made good progress some thirty years ago in providing steel shoeing for the solid rubber tyres he then used, and the problems of providing the same for pneumatic tyres ought to be no harder than those he then successfully encountered.

One of the topics which has been most strongly discussed during the last year has been the position which this country holds relatively to other countries as regards its commercial supremacy in engineering matters. A few years back we were undoubtedly ahead of the world in most branches of mechanical engineering, but owing to the huge development of mechanical engineering in America and Germany, we are certainly being run very hard by these countries, and everyone is looking for means to help us to regain our old position. In endeavouring to learn from America we see that, although the workmen in that country receive higher wages than they do here, and although the cost of some of the materials is higher than it is here, their manufacturers manage to deliver engines, tools, and machinery of all classes of excellent quality at a price which appears to our manufacturers to be marvellously low. When we look into the matter we find that the chief difference between the manufacturer of America and the manufacturer at home is that, whether it be steam-engines, tools, agricultural machinery, or electrical machinery, the American invariably manufactures goods in large quantities to standard patterns, whereas we rarely do so here, at any rate to the same extent. Where we turn out articles by the dozen the American turns them out by the hundred. This difference in the extent to which an article is reduplicated is caused by the Americans having realised to a far greater extent than we have the advantage of standardisation of types of machinery. They have felt this so strongly that we find in America that work is far more specialised than it is here, so that a manufacturer as a rule provides himself with a complete outfit of machinery to turn out large numbers of one article. He lavishes his expenditure on special machinery to produce every part sufficiently accurate to dimension to secure thorough interchangeability; consequently the cost of erecting or assembling the parts is far less than it is here. One reason why the American manufacturer has been able to impose on his purchasing public his own standard types, whereas we have not been able to do so, is that very rarely in America does a consulting engineer come between the manufacturer and the user, whereas here it is the fashion for the majority of purchasers of machinery to engage a consulting engineer to specify and inspect any machinery of importance. By this I do not impute any blame to our consulting engineer; he considers the requirements of his client, and insists that they are to be adhered to as closely as possible; to him the facility of the production of articles in large quantities is of no moment. In America it seems to be understood by the purchaser that it is a distinct advantage to everyone concerned, both manufacturer and purchaser, that the purchaser should to some extent give way and modify his requirements so as to conform with the standard patterns turned out by the manufacturer. Although manufacturers all hope for this simplification of patterns, yet, for the reasons I have given, it will be some time before their hope is realised. But on other matters it is quite possible for manufacturers to combine, so as to obtain some standardisation of parts which they manufacture which will reduce costs and be of advantage to everyone concerned. Many years ago Sir Joseph Whitworth impressed on the world the importance in mechanical engineering of extreme accuracy, and of securing the accurate fit and interchangeability of parts by standard gauges. But in spite of his idea being so widely known and taught, how seldom it has been acted upon to the extent that it should be. We pride ourselves on having all our screws made of Whitworth standard, and yet how many of the standard bolts and nuts made by different makers fit one another? I myself have sat on a committee of this Association which was called together twenty years ago, with Sir Joseph Whitworth as a member of it, to fix on a screw gauge which would be a satisfactory continuation of the Whitworth screw gauge down to the smallest size of screw used by watchmakers.[1] It has taken all these years to carry out the logical outcome of Sir Joseph Whitworth's original idea, viz. the providing of standards to be deposited in care of a public authority to act as standard gauges of references. The complete interchangeability of parts which I have above referred to, and which is so desirable in modern machinery, can, of course, be obtained within the limits of one works by that works providing and maintaining its own standards to a sufficient degree of accuracy. But if the articles be such as watches or bicycles, motor-cars, &c., it is very desirable that all parts liable to require replacement should be made by all manufacturers to one standard of size, and in order that the gauges required for this purpose should all be exact copies of one another it is necessary that they should be referable to gauges deposited either with the Board of Trade or with some body specially fitted to verify them and maintain their accuracy.

Up to the present the Board of Trade has dealt with the simple standards of weight, capacity, and length, but in other countries National Standardising Laboratories have been provided, viz. by the Germans at their Reichsanstalt at Charlottenburg, and with the happiest results; here at last, through the exertion of the Council of the Royal Society, our Government has been moved to give a grant in aid and to cooperate with the Royal Society to establish a National Physical Laboratory for this country. About ten years ago Dr. Oliver Lodge gave the outlines of a scheme of work for such an institution. Later Sir Douglas Galton, in his Presidential Address to this Association, called attention to the good work done by the Germans and the crying need that existed for such an institution in this country. The matter has since progressed. A laboratory is already in existence, and will soon be at work, at Bushey House, Teddington; it is a large residence, which was once occupied by the late Duke of Clarence and afterwards by the Duc de Nemours. It will make an admirable laboratory, as it has large and lofty rooms and a vaulted basement in which work can be carried on where it is important to secure the observer against changes of temperature.

[1] A report of this committee will come before you during this meeting.

The aims of a National Physical Laboratory have been well put forward by Dr. Glazebrook in a recent lecture at the Royal Institution, in which he points out how little science has up to the present come to be regarded as a commercial factor in our commercial world. The position of manufacturers of all classes must be helped and improved by a well-considered series of investigations on the properties of materials, measurements of forces, and by the careful standardisation of and granting certificates to measuring apparatus of all classes. Until the question is fairly faced and studied, few manufacturers realise how helpless individual effort or individual investigations must be when compared with comprehensive and continuous investigations which can be carried on by a National Laboratory so as to deal with the whole of each subject completely and exhaustively, instead of each investigation being limited by the temporary need of each manufacturer or user.

As an example Dr. Glazebrook showed how much has been done at Jena and afterwards at the Reichsanstalt in the development of the manufacture of glass used in all classes of scientific apparatus. The German glass trade has benefited enormously from these investigations. The microscopic examination of metals, which was begun by Sorby in 1864, has been much worked at by individual investigators in this country, but its further development, which is probably of enormous importance to arts and manufactures, is clearly the duty of a National Laboratory. We owe much to the investigations of the Alloys Research Committee of the Institution of Mechanical Engineers; but, again, this is work for the National Laboratory. As regards the measurement of physical forces how little is accurately known of the laws governing air resistance and wind-pressures, and the means of measuring them. Who can formulate with any certainty a law for the air resistances likely to be met with at speeds in excess of eighty miles an hour, the importance of which I have already noticed?

I have already alluded to the verification, care, and maintenance of ordinary standard gauges of accuracy. In this electrical age the accuracy of electric standards is of supreme importance.

These are only a few of the directions in which we can foresee that the establishment of a National Physical Laboratory will be of the greatest use and assistance to our country in enabling it to hold its own in scientific and engineering matters with its energetic rivals. The work has been commenced on a small scale, but it is to be hoped that its usefulness will become at once so evident and appreciated that it will soon be developed so as to be worthy of our country.

NOTES.

AN expedition to Patagonia has been undertaken, under the auspices of the French Minister of Public Instruction, by M. A. Tournouër, whose purpose is to continue his study of the Tertiary mammals of South America.

THE last number received of the *Victorian Naturalist* states that, on July 19, Prof. Baldwin Spencer telegraphed from Alice Springs that his expedition had finished its work at Barrow Creek, where six weeks had been spent among the Kaitish and Ummatjera tribes. Much valuable information relating to tribal organisations, totemic systems, &c., had been collected, and a fine series of photographs of sacred ceremonies, types of natives, &c., secured. The next main camp was to be formed at Tennant's Creek, about 150 miles further north (latitude 19° 30′ S.). The members of the party were in excellent health, and well pleased with the results of their work.

A TELEGRAM from Berlin, through Reuter's agency, states that the Chinese astronomical instruments which the Germans carried off from Peking have now been placed in the orangery in Sans Souci Park. The instruments were packed in fifty-six cases, and weighed 26,000 kilogrammes. It is stated in the *Cologne Gazette* that the German Government authorised their purchase by the German Minister in Peking, after the offer of the Chinese Government to make the German Emperor a present of them had been declined.

THE governors of the Bristol General Hospital have been authorised by Sir William Henry Wills to draw on him up to 600*l.* for the provision of the Finsen apparatus for the treatment of lupus.

THE Philosophical Society of Glasgow will in future be known as the Royal Philosophical Society of Glasgow, the change taking place by the King's pleasure in respect of the near approach of the hundredth anniversary of the foundation of the Society.

A MISSION, consisting of three or four members, which will be under the direction of the Pasteur Institute, will start next month from France for the study of yellow fever. The sum of 100,000 francs has been voted by the Chamber of Deputies and the Senate towards the cost of the expedition. Operations will, if possible, be begun first in Brazil.

A SPECIAL COMMISSION to inquire into the subject of irrigation in India will meet in Simla in October under the presidency of Sir Colin Scott Moncrieff. The Commission, which will take evidence, examine proposed projects and formulate conclusions for the guidance of the Government, will visit the Punjab and the irrigation colonies in Sindh, Gujarat, the Deccan, Madras, the Central Provinces, and Upper India.

OWING to losses in the staff by death and retirement, the following appointments have been made on the Geological Survey of the United Kingdom. Dr. J. S. Flett has been selected to assist in the petrographical work of the Survey, Mr. J. Allen Howe and Mr. H. H. Thomas have been appointed geologists on the English staff, Mr. H. B. Muff on the Scottish staff, and Mr. W. B. Wright on the Irish staff.

REALISING, from the experience gained on the steamship *Lucania*, the value of the Marconi system of wireless telegraphy, the Cunard Company have decided to fit three more of their vessels with the same apparatus, viz. the *Campania*, the *Umbria* and the *Etruria*.

ON Saturday last, at Dundee, a granite monument was unveiled to the memory of James Bowman Lindsay, an investigator and inventor whose experiments in connection with wireless telegraphy and other scientific advances fifty years ago ought not to be forgotten. Sir William Preece, in unveiling the monument, remarked that Bowman Lindsay was long before his time. He was a prophet who would compare with any prophet, for in 1834 he wrote that houses and towns would in a short time be lighted by electricity instead of gas, and heated by it instead of coal, and machinery would be worked by it instead of by steam. Sir William Preece recollected that while he was attached to the electrical department of the Electric Telegraphs Company there came from Dundee to London a gentleman with a proposal to dispense with wires and communicate across water. He was attached to Mr. Lindsay, and he made all the arrangements and conducted all the experiments to illustrate his system in London. Unfortunately there was really no necessity for the invention in those days. An invention to be of use must come at the proper time. There must be the want for it, otherwise it died. This accounted for the fact that the system of wireless telegraphy which was now associated with the name of Lindsay had been neglected.

THE *Electrician* states that a proposal has been submitted to the municipal authorities at Rouen, by the chief of the fire department, for the utilisation of the tramway trolley wires in connection with the extinguishing of fires. All the principal thoroughfares of the town are provided with electric tramways, and the proposal is that pumps capable of being electrically driven should be installed in a number of suitable positions on the tramway route, to be switched on to the trolley wires, so that the pumps may be used as occasion necessitates. The proposal is said to have been favourably received, and is now under the consideration of the authorities.

AN experimental test of Prof. Koch's theory that bovine tuberculosis is not transmissible to human beings is, says the *British Medical Journal*, about to be undertaken under the direction of the Chicago Health Department.

AN earthquake shock was experienced at Inverness at 1.25 on Wednesday morning, and a lighter shock was also felt at four o'clock. A rumbling sound was heard during the first disturbance, and buildings were shaken to such an extent that windows rattled, objects were thrown down, a few chimney-pots were toppled over, and bells were set ringing. The movement appeared to travel from south to north, and reports of its occurrence have been received from Ava, Invergordon, Kildary, Alness, Newtonmore, Pitlochry, Loch Errich, Aberdeen, and other places.

A RESEARCH INSTITUTE has been opened by the Government of the Malay States at Kuala Lumpur, near Singapore. The medical department is fully equipped for special and general pathological work for the scientific study of clinical medicine, experimental physiology, and bacteriology. The chemistry department is arranged for both organic and inorganic research. There are, in addition, a well-stocked photographic department, facilities for biological research, and a good library. To members of scientific commissions visiting the Malay Peninsula the Institute affords an excellent opportunity for working up and preparing collected material. The Institute is open to all workers irrespective of nationality.

THE council of the University of Bordeaux is, with the approval of the French Minister of Public Instruction, founding a diploma in colonial medicine. The diploma, says the *Lancet*, will be granted, after keeping of terms and passing an examination, (1) to doctors in medicine of a French university; (2) to doctors in medicine of foreign universities; and (3) to foreigners having a medical diploma which is recognised as equivalent to a French doctorate of medicine. The examination will comprise (*a*) a clinical examination in tropical pathology; (*b*) a practical examination in the demonstrations and manipulations which have been gone through during the terms; and (*c*) a *viva voce* examination upon the subjects taken up during the course of study.

A CENTRAL NEWS telegram from New York, dated September 13, states that Mrs. Peary, the wife of the Arctic explorer, has arrived at Sydney, Cape Breton, from the Polar regions. She reported that she met her husband in the vicinity of Cape Sabine on May 6. Lieutenant Peary informed her that he spent the winter of 1900 at Fort Conger. This summer he marched northward to Independence Bay, but was then compelled to return to Fort Conger, where he will again spend the winter. A Reuter telegram states that the explorer had rounded the northern limit of the Greenland archipelago, and had reached latitude 83° 50′. He proposes to resume his attempts to reach the Pole in the spring of 1902.

THE twenty-ninth annual meeting of the American Public Health Association was to be opened at Buffalo on Monday last, and to continue in session, under the presidency of Dr. Benjamin

Lee of Philadelphia, until Saturday of the present week. The following is a list of the subjects down for discussion:—The pollution of public water supplies; the disposal of refuse material; animal diseases and animal food; car sanitation; etiology of yellow fever; steamship and steamboat sanitation; relation of forestry to the public health; demography and statistics in their sanitary relation; cause, prevention and duration of infectious diseases; public health legislation; cause and prevention of infant mortality; disinfectants and disinfection; national leper homes; dangers to the public health from illuminating and fuel gas; transportation of diseased tissue by mail; the teaching of hygiene and granting of Diploma of Doctor of Public Health; school hygiene; sanitary aid societies. In the Section of Bacteriology and Chemistry the following questions will be discussed: On standard methods of water analysis; bacteriology of milk in its sanitary relations; variations of the colon bacillus in relation to public health; and exhibition of laboratory apparatus and appliances for teaching hygiene.

A MEETING of the Yorkshire Naturalists' Union will be held at Cadeby (near Doncaster) from Saturday to Thursday, September 21–26, for a fungus foray in the neighbourhood of Melton, Sprotborough and Warmsworth.

THE Government of Victoria, Australia, requiring a director of agriculture, the U.S. Department of Agriculture has recommended for the post Prof. B. T. Galloway, chief of the Bureau of Plant Industry, and Prof. W. M. Hays, agriculturist of the Minnesota Experiment Station.

THE Allahabad *Pioneer Mail* states that a scheme is under consideration by the trustees of the Indian Museum to abolish, on the ground of expense, the office of the trustees and to allow the work to be managed by the librarian of the Museum. The scheme was formally brought before a meeting of trustees recently to be cast into shape before being forwarded to the Government of India for sanction. It is understood that Mr. Risley, chairman of the trustees, has already approved of the more important points of the scheme in consultation with the Revenue and Agricultural Department of the Government of India.

DR. DAVID STARR JORDAN, president of Stanford University, Dr. Barton W. Evermann, ichthyologist of the U.S. Fish Commission, and Dr. W. H. Ashmead, of the U.S. National Museum, who spent the summer in the Hawaiian Islands investigating on behalf of the U.S. Government the fishes and other aquatic resources of the Islands, have now returned to the United States, says *Science*. The other members of the party will return during the present month, except Messrs. L. E. Goldsborough and George Sindo, who will go to Pago Pago in the Samoan Islands to make a collection of the fishes found there. The investigations are reported to have been very successful. The fishery methods, laws and statistics were carefully studied and large and important collections of the fishes were made. Upwards of 300 species were obtained, among which are many species new to science. A preliminary report will be shortly submitted to the Commissioner of Fish and Fisheries. The final report will not be made until more deep-sea work has been done about the islands.

THE Congress of the International Association for Testing Materials was held at Budapest on September 9 to 14, under the presidency of Prof. L. von Tetmajer, and was largely attended by engineers from all parts of the world. The delegates present included 4 from England, 41 from Austria, 3 from Belgium, 9 from Denmark, 2 from the United States, 36 from France, 152 from Hungary, 70 from Germany, 3 from Norway, 12 from Italy, 26 from Russia, 1 from Roumania, 3 from Spain, 1 from Servia, 10 from Switzerland and 5 from Sweden. After an inaugural presidential address and address of welcome from the Hungarian authorities, a representative of each country was elected an honorary president of the Congress, Mr. Bennett H. Brough being chosen for England and Prof. H. M. Howe for the United States. The other English and American members present were:—Sir William H. Bailey (Manchester), Mr. Bertram Blount (London), Dr. C. J. Renshaw (Ashton-on-Mersey) and Dr. R. Moldenke (New York). In addition to the various reports of committees dealing with technical problems, the following papers dealing with metals were read and discussed:—on the measurement of internal tension, by Mr. Mesnager (Paris); on the forms of carbon in iron, by Baron Jüptner (Leoben); on Brinell's researches, by Mr. A. Wahlberg (Stockholm); on the testing of metals by means of notched bars, by Mr. H. Le Chatelier (Paris), by Mr. G. Charpy (Paris) and by Prof. Belelubsky (St. Petersburg); on micrographical researches on the deformation of metals, by Mr. F. Osmond (Paris); on metallography, by Mr. E. Heyn (Charlottenburg); on the testing of railway material, by Mr. E. Vanderheym (Lyons); and on the international iron and steel laboratory, by Prof. H. Wedding (Berlin). Several papers dealing with stone and mortars were also read, and an interesting lecture on the iron industry of Hungary was delivered by Prof. Edvi-Illes (Budapest).

Two long and highly sensational letters, entitled "A New Record of Totemism" and "The Early Man and his Stones," by the Hon. Auberon Herbert, have appeared in the *Times* of the 3rd and 7th inst. respectively, describing what he believes to be an important discovery of worked flints. His view, in brief, is that very extensive gravel beds in south Hampshire are practically entirely composed of worked flints which have been carried to their present position by man and then rearranged by water. The age and mode of formation of the gravel beds is a matter for the geologists to determine, and there is little doubt as to what they will say about the origin of the gravels. Archæologists must decide on the question whether the specimens submitted to them by Mr. Herbert are natural forms or artifacts. Judging from the numerous instances of analogous finds the verdict will be against Mr. Herbert's hypothesis; but he may rest assured that if he produces his evidence it will receive due consideration from anthropological or archæological experts. Mr. Herbert sees in his specimens animal and other natural forms, and arrives at the conclusion that they were "totems." Totemism, however, has too long been a "blessed word," and the time has arrived when strong protest must be made against the misuse of the term. There are many animal and plant cults in the world, and totemism is one of them; indeed it is probable that what is described as totemism among one people may be different from what is called totemism elsewhere. Should this prove to be the case the term should be restricted to practices and beliefs which are undoubtedly similar to those of the Ojibway cult. It is entirely unwarrantable to speak of every animal cult as totemism; the elucidation of primitive beliefs is rendered more difficult, one might say it is made almost impossible, by such looseness of terminology. It is not going too far to assert that whatever the stones may be they can never be proved to be totems or representations of totems.

DR. CARL LUMHOLTZ, the Norwegian explorer, who for the past five years has been travelling in the hitherto unknown regions of North-Western Mexico for the American Museum of Natural History, lectured before the Geographical Society in Christiania on September 12 and gave a description of his life and travels among the wild Indian tribes of the Western Sierra Madre, and especially among the cave-dwellers, who still live in the same primitive way as their forefathers thousands of years ago. In order to study these interesting people he sent back the entire staff of his expedition and lived alone among them. At first the tribes objected to his taking up his abode in this way, but eventually he gained their confidence and was allowed to remain. He learnt their ways, their language and their songs, and joined in their dances. The Mexican Indians are monogamists, and lead, on the whole, a happy existence. They are very intellectual, and are, according to Dr. Lumholtz, a far superior race to their kinsmen in the United States and South America. Among many of the tribes he found a higher degree of morality than in civilised countries. Theft and many of the worst forms of disease are unknown among them. The land is held in common. Their principal food consists of Indian corn and beans. The large and interesting collection of native pottery and implements which have been brought away for the American Museum of Natural History, and the explorer's researches into the life, customs, religion, &c., of the natives, will, it is thought, throw a new light upon many hitherto unknown periods in the history and evolution of mankind.

WE have received a copy of the Meteorological Observations for the year 1900, taken at Rousdon Observatory, Devon, under the superintendence of the late Sir Cuthbert E. Peek, Bart. This valuable series of observations was commenced in 1883, as a station of the second order, and subsequently important additions have been made, including Robinson and Dines' anemometers. In addition to the usual observations, which have been regularly and carefully made, as in former years, by Mr. C. Grover, much useful experimental work has been carried on, including a comparison of rainfall at different heights and of records of different types of anemometers. A comparison of the weather experienced at the Observatory with that predicted for the district by the Meteorological Office has been made daily since 1883. The percentage of absolute success during the year 1900 amounted to 85, and shows a considerable improvement on some of the earlier years. In an appendix the average monthly and yearly meteorological results for the seventeen years 1884–1900 are given in English and French measures.

A SERIES of papers on the radiation from carbon is commenced by Mr. E. L. Nichols in the *Physical Review* for August. The object of the experiments is to measure the temperature of carbon rods rendered incandescent by the passage of an electric current, and to make spectrophotometric comparisons of the visible radiation from their surfaces with the corresponding wave-lengths in the spectrum of an acetylene flame.

A SIMPLE circular slide-rule is described by M. Pierre Weiss in the *Journal de Physique* for September. It possesses only a single graduated dial, the logarithmic scale going from 1 to 10 in 360°, but it has two needles, one pivoted inside the other, so that when the latter is revolved the former turns with it. In order to multiply a by b, one needle is placed opposite unity and the other opposite a. The needles are then revolved together until the first needle is opposite b, the second will then be opposite the reading corresponding to the product ab. To perform division or to find the fourth proportional to three given numbers by a single operation, the method is closely analogous to that with a slide-rule.

IN a recent issue of the *Proceedings* of the Philadelphia Academy, Dr. A. M. Reese describes the evolution of the nasal passages in the Florida alligator. In the same journal Mr. H. A. Pilsbry records a number of additions to the land-snail fauna of Japan.

THE following recently appeared in the *Daily Telegraph* :—"Experts in the British Museum are investigating an extensive discovery of sharks' teeth and the palates of other fish which has been made in Goldsworth Cutting, Woking, during the excavations for the widening of the London and South-Western main line. The teeth, which were found in large numbers in the greensand formation, about 35 feet below the subsoil, are in a state of splendid preservation, and the find is regarded as an unusually interesting one." The specimens are really of Tertiary age.

IN a series of "Notes from the Gatty Marine Laboratory, St. Andrews," published in the *Annals and Magazine of Natural History* for September, Prof. M'Intosh discusses the enormous destruction of ova and fry which occurs in certain shore fishes, such as the shanny, blenny, cottus and lump-sucker (the eggs of which were recently produced to the Royal Commission on Trawling as those of the haddock). With regard to food-fishes, Prof. M'Intosh takes a hopeful view, urging that they "are in no great danger of extinction by the operations of man. These fishes have a vast area of water, which is utilised not only for the migrations of the adults, but for the spread of the pelagic eggs, larvæ, post-larval forms and adolescents. Even were the inshore flat-fishes, for instance, to be reduced to such a degree that their capture would no longer be profitable, that fact would be their safeguard, for they would be left, amidst the most favourable surroundings, to augment their decimated ranks."

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, presented by Lieut. R. P. Crawley; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. L. H. Ellis; a Bosman's Potto (*Perodicticus potto*), an African Civet Cat (*Viverra civetta*) from West Africa, presented by Mr. H. W. L. Way; two Lapwings (*Vanellus vulgaris*), European, presented by Mr. L. J. Coussmaker; twenty Rhomb-marked Snakes (*Trimerorhinus rhombeatus*), twenty-two Crossed Snakes (*Psammophis crucifer*), seventeen Rufescent Snakes (*Leptodira hotamboeia*), seven Rough-keeled Snakes (*Dasypeltis scabra*), three Infernal Snakes (*Boodon infernalis*), a Lineated Snake (*Boodon lineatus*), a Smooth-bellied Snake (*Homalosoma lutrix*), an Oldham's Snake (*Chlorophis hoplogaster*) from South Africa, presented by Mr. W. A. Guthrie; eleven Tenrecs (*Centetes ecaudatus*) from Madagascar, a Barnard's Parrakeet (*Platycercus barnardi*), a Yellow-rumped Parrakeet (*Platycercus flaveolus*) from South Australia, a Yellow-fronted Amazon (*Chrysotis ochrocephala*) from Guiana, a Red-vented Parrot (*Pionus menstruus*), twelve Brazilian Tortoises (*Testudo tabulata*) from South America, three West Indian Agoutis (*Dasyprocta cristata*) from the West Indies, two Rollers (*Coracias garrulus*), European; two Grey Monitors (*Varanus griseus*) from North Africa, two Starred Tortoises (*Testudo elegans*), three Ceylonese Terrapins (*Nicoria trijuga*), a Bungoma River Turtle (*Emyda granosa*), five Bengal Monitors (*Varanus bengalensis*) from India, deposited; a Proteus (*Proteus anguinus*) from the Caves of Carniola, presented by Mr. G. Churchill.

OUR ASTRONOMICAL COLUMN.

DIAMETER OF MERCURY.—Prof. T. J. J. See has recently made a long series of determinations of the diameter of the planet Mercury, using the filar-micrometer on the 26-inch refractor of the U.S. Naval Observatory at Washington. Details of 145 observations are grouped in three series, extending over the period 1900 June 20–1901 June 11. The mean diameter deduced is

$$D = 5''{\cdot}8993 \pm 0''{\cdot}0080.$$
$$= 4277{\cdot}6 \text{ km.} \pm 5{\cdot}8 \text{ km.}$$

Special attention is drawn to the absence, even under the best conditions, of any markings which could be recognised with certainty.

There was no noticeable falling off in the brightness of the planet near the limb, so that there appears to be no evidence of any kind of atmospheric absorption on Mercury.

The paper concludes with a list of previous measures of the diameter, and a discussion of the reasons why heliometer and filar-micrometer measures of diameter do not always agree, the discrepancy being ascribed chiefly to the distortion produced by the division of the objective in the heliometer (*Astronomische Nachrichten*, Bd. 156, No. 3737).

PERIODICITY OF THE INEQUALITIES OF MERCURY.—In the *Bulletin de la Société Astronomique de France*, pp. 402–403, 1901, M. Souleyre gives some results of his investigations into the variation of the inequalities of the planet Mercury. The times of contact of the planet with the sun's disc have been reduced from the observations available during the period 1677–1894, and the residuals are found to have a probable relation to the sun-spot period, inasmuch as the errors are all *positive* at or near the years of sun-spot *maxima*, and *negative* about the times of sun-spot *minima*. A rather discordant value is found for 1894, but the error is very small for that year.

The mean error for years of maxima is about +6 seconds, and
,, ,, ,, minima ,, −9 ,,

EVIDENCE OF THE EXISTENCE OF AN ULTRA-NEPTUNIAN PLANET.—In a paper read before the Royal Society of Edinburgh (*Proc.* Roy. Soc. Edinburgh, vol. xxiii. pp. 370–374), Prof. G. Forbes outlines the observations and calculations which he considers indicate the probable existence of a planet beyond Neptune. The chief factor on which the discussion is based is the proposition enunciated by Prof. Newton in 1879, stating that *if the elliptic orbits of comets have been changed from parabolas by planetary perturbations*, then the aphelion position of the new orbit will most probably be that occupied at the time of change. Prof. Forbes in 1880 (*Observatory*, June 1880) found that seven comets had aphelia distances about equal to one hundred times the mean distance of the earth from the sun.

The present note then deals more particularly with the recent discovery of a remarkable confirmation of these original results. The comet of 1556 (possibly identical with that of 1264) was not detected in 1848, and the computations undertaken show that the longitude of the new planet in 1696 was 112°, and its distance about one hundred times the earth's mean distance. The number of comets affected by these observed perturbations is so large that the new planet is probably greater than Jupiter.

A minute examination of all the comets in Galle's Catalogue showed the author that no one of them represented the lost comet of 1556, and a further search has been made among those comets to which elliptic orbits have not yet been assigned. Of these comets 1844 iii. or 1843 ii. turn out to have aphelion longitudes near 115°. This position, he calculated, would be occupied by the hypothetical planet about 1705, and if the former comet (1844 iii.) should be the representative of the long lost comet 1556, the observed perturbations would all be as required by the theoretical deductions, viz. the node has retrograded considerably, the inclination greatly increased, and the longitude of perihelion advanced. The chief discrepancy is in the latitude of aphelion, which is smaller than would be expected. It thus appears that the long lost comet 1556 is represented by that of 1844 iii. perturbed by a planet considerably larger than Jupiter, situated at about one hundred times the mean distance of the earth from the sun, and whose longitude is about 181° in the present year 1901. A re-examination of the 1556 observations is in progress, in the hope of finding more definite information.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Sunderland Municipal Technical College, which has been erected at a cost of 27,000*l.*, was opened on Friday last.

THE new technical school at Liverpool, the foundation stone of which was laid on July 1, 1898, is now practically completed and will shortly be opened. The school will accommodate 1300 students. The rooms devoted to chemistry and navigation are already in use.

MR. W. J. POPE has been appointed professor of chemistry and head of the chemistry department at the new Municipal School of Technology at Manchester. He has been succeeded as head of the chemistry department of the Goldsmiths' Institute, New Cross, by Dr. A. Lapworth.

A HANDY little diary and note book, which should be useful to students, has been issued by Messrs. Philip Harris and Co., Ltd., of Birmingham. It contains information as to the subjects and dates of the forthcoming examinations in connection with the Board of Education, City and Guilds of London Institute, &c.

MR. R. M. FERRIER, late lecturer in mechanical engineering at the Durham College of Science, Newcastle-upon-Tyne, has been appointed to the professorship of engineering at University College, Bristol, in the room of Dr. Stanton, whose appointment to the National Physical Laboratory was recently announced.

THE new laboratory and class rooms of the Muir Central College, Allahabad, described in a recent number of the *Pioneer Mail*, are in marked contrast to the rooms hitherto devoted to science in the institution. Judging from our contemporary's description, no pains have been spared to give the College sufficient accommodation and apparatus for the carrying on of scientific instruction.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 9.—M. Bouquet de la Grye in the chair.—Observations of the planet GQ, made at the Observatory of Algiers with the 0·318 metre equatorial, by M. F. Sy. The apparent positions of the planet, the positions of the comparison stars, and the magnitudes, were measured on the five nights August 21 to 26. The magnitude varied between 8·5 and 9·6.—On the existence of fundamental functions, by M. W. Stekloff.—On integral invariants, by M. Th. de Donder.—On the impossibility of representing by isophygmic curves the distribution of instability in a given seismic region, by M. F. de Montessus de Ballore. The author concludes that since seismic phenomena are essentially discontinuous both in time and space, the isophygmic curves can have no real existence. Proof of this is found in the paper by Oldham on the aftershocks of the great earthquake of June 12, 1897.—On the simultaneous appearance of mosquitoes of the genus Anopheles and the first cases of malarial fever in the region of Constantine, by M. A. Billet. The first cases of malaria occurring during the season were nearly simultaneous with the first appearance of the mosquito. The proof in one case of the presence of the malarial sporozoites in the Anopheles presents a particular interest.—On the biology of *Galeruca xanthomelaena*, by M. A. Menegaux.

CONTENTS.

THURSDAY, SEPTEMBER 26, 1901.

TOWERS AND TANKS FOR WATER-SUPPLY.

Towers and Tanks for Water-Works. The Theory and Practice of their Design and Construction. By J. N. Hazlehurst. Pp. ix+216. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1901.) Price 10*s.* 6*d.*

THIS book deals exclusively with a special subject relating to water-supply, namely, the design and construction of metal stand-pipes and tanks for storing up water at a sufficient elevation to provide adequate pressure for its proper distribution. An illustration of a stand-pipe, 20 feet in diameter and 120 feet high, at St. Augustine, Florida, is given in the frontispiece; and a view of a high cylindrical tank raised on a tower, or more strictly a trestle, consisting of light metal standards braced together, erected for the water-supply of West Tampa, Florida, is shown opposite p. 116; and these two examples very fairly indicate the structures which form the subject of the volume. These stand-pipes and tanks, besides serving as reservoirs for the storage of an adequate supply of water to meet any sudden increased demand, and admitting of a temporary suspension of the pumping, are also valuable as regulators of the distribution, and as relief-valves for preventing the occurrence of undue stresses in the pipes in the process of pumping.

A considerable number of municipal water-works in the United States have been furnished with some form of metallic reservoirs, especially within recent years, in places where there is not a suitable site at a sufficient elevation for the construction of an ordinary reservoir of earth or masonry. Thus, out of more than three thousand complete municipal water-works in the United States, nine hundred and ninety-two have been equipped with elevated metallic reservoirs, five hundred and thirty-five of which have been erected since 1890. These structures exhibit great variety in their dimensions; for the largest tank in the United States, erected at Greenwich, Connecticut, in 1889, is made of wrought iron, 80 feet in diameter and 35 feet high, having a capacity of nearly 1,320,000 gallons, and rests on a concrete foundation; whilst a steel stand-pipe erected at Winona, Minnesota, in 1876, has a diameter of only 4 feet, and a height of 210 feet, with a capacity of 20,000 gallons, and rests upon a masonry foundation 18 feet thick.

Stand-pipes are by far the most common form of metallic reservoirs adopted in the United States, exceeding eight hundred in number; but steel tanks supported at the requisite height on steel trestles are now very often preferred, as a cheaper and safer way of supporting the effective upper column of water, 20 to 30 feet high, than by a column of water below enclosed in a cylinder; and already one hundred and sixty-one such tanks have been erected, most of them since 1890. The stand-pipes vary, for the most part, from 50 to 120 feet in height and from 11 to 39 feet in diameter, being exposed to maximum pressures of 82 to 130 lbs.; whilst their average dimensions and pressures are, 63 feet height, 20 feet diameter, with a capacity of 150,000 gallons, an ordinary pressure in the distributing pipes of 62 lbs. per square inch, and an emergency pressure of 104 lbs. The tanks, on the average, have a height of 37 feet, a diameter of 21⅓ feet, a capacity of 101,000 gallons, and an elevation on a trestle, or tower, of 63½ feet. To obtain the average pressure of 62 lbs., the effective height of the stand-pipe or tank would require to be 142 feet; but generally advantage can be taken of some natural elevation in the neighbourhood to reduce the actual height of the stand-pipe or tank. A chapter is devoted to the design of each of these structures, dealing also, in the case of stand-pipes with the bed-plate, connections, stiffener at the top against wind, and anchorage, and in the chapter on tanks, with wind-bracing and anchorage.

The author, however, leads up to the subject of design by five preliminary general chapters, on the chemical and physical properties of wrought iron and steel, the relative merits of these metals, the stability of structures, mechanical principles, and riveting; and after the two chapters on designing, he proceeds to deal, in three successive chapters, with foundations, painting, and shop-practice and erection. Accordingly, the book embraces a wider range of subjects than might be anticipated from its title; and by a very comprehensive treatment, a complete guide is provided for the design and construction of a special class of structures, of limited application, which have not hitherto received adequate consideration.

ELEMENTARY ZOOLOGY.

Animal Life: a First Book of Zoölogy. By President D. Starr Jordan, Ph.D., LL.D., and Prof. V. L. Kellogg, M.S. of Leland Stanford Junior University. Pp. ix+329. (London: H. Kimpton, 1901.)

THIS volume is one of the twentieth century text-book series, and adds another to the rapidly growing stock of elementary science manuals. It contains more than 300 pages, with 180 text figures, and its only novelty is the method of treatment, the authors combining the most elementary detail with the most abstruse ideas set forth in simple language. The reason of this is their conviction that "the veriest beginner ought to be an independent observer and thinker," and that "the point of view which the zoölogical beginner should take is the point of view that the best and most enlightened zoölogical scholar takes."

There are sixteen chapters to the book, with a brief classification and a glossary. The lives of the simple and the more complex organisms are first dealt with, then come chapters on multiplication and sex, on function and structure, on the life cycle, and so on. The struggle for existence, adaptation, commensalism and symbiosis, parasitism, protective resemblance, and other topics are all in turn considered, and the whole closes with a chapter on distribution.

There are incorporated in the book a selection of the elementary facts and the commonplaceisms of the modern fantasies of zoology. Both are reasonably dealt with, but we find nothing for very especial comment. Novelty mainly attaches to some of the illustrations; for example, the frontispiece—a photograph of a group of red-faced cormorants—a companion plate of a family of fur seals, a striking picture of the angler fish (Corynolophus) enticing its prey (not lighting up the sea-bottom this time !), an irresistible group of nestlings of the Canada jay, and a trio of manatees depicting three leading attitudes, make up a selection which is altogether admirable, and if for only these the book deserves support. On the contrary, however, illustrations such as those which do duty for a transverse section of a Hydra, for a tactile papilla and that of the calf's tongue, are beneath criticism; and doubtful to a degree are the incorporation in such a book as this, as all-typical, of such forms as Gonium, Calcolynthus, and Prophysema, about the latter two of which the less that is put before the elementary student the better. Old friends are with us, as, for example, the puss moth larva, with its "intensely exaggerated caricature of a vertebrate face." Anthropomorphic truly; but is this science?

We assume the authors would have the beginner read this book while prosecuting a more detailed study of individual forms, as with the now universal type-system. Its appearance within a year of Davenport's "Introduction to Zoology," a book of somewhat kindred aims, betokens a desire on the part of those responsible for the elementary scientific education of young America for a liberalising and humanising influence. The experiment is an interesting one, and it in some respects meets the ever-recurring question of the teacher, "What best can I give the student to read?" The lines on which the book is written appear to us risky in their great breadth and cursoriness; but while we await the result of experience before pronouncing further upon the book we admit that salient truths are expressed in a refreshingly familiar way, and that it is pleasant reading. The authors have fallen into the common error of according uneven recognition to authority, as, for example, in attributing the well-known series of drawings of Amœba to Schulze on p. 8, but not on p. 53, where at least a cross reference should have been inserted.

OUR BOOK SHELF.

Gustav Theodor Fechner. By W. Wundt. Pp. 92 (Leipzig: Engelmann, 1901.) Price 2*s*. net.

G. T. FECHNER, at once a distinguished and industrious devotee of exact research, and a poetic and religious enthusiast, is a most attractive figure in the history of German thought in the nineteenth century; and in the lecture delivered by Prof. Wundt before the Royal Society of Saxony in commemoration of the hundredth anniversary of his birth (April 19), the general reader will find a readable account of him which is composed with the double authority of a personal friend and colleague and of a successor.

The chief interest of the lecture itself lies in the proof that Fechner was first led to the psychophysical work by which he will be best remembered from a desire to find experimental confirmation for his poetico-philosophical theory of the universal animation and intelligence of physical nature.

Many readers will perhaps turn with most interest to the section of the appendix which contains the author's personal reminiscences of his famous predecessor. It is curious to learn from Prof. Wundt that Fechner's interest in the experimental psychology of which he was the originator was entirely confined to the problem of the so-called "logarithmic law" of psychophysical action, and that he could not be brought to read exact researches into other psychological questions. A. E. T.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Two Problems of Geometry.

IN your issue of August 22, Mr. A. B. Basset asks for solutions of the two problems, the trisection of an angle by means of the cissoid, and the duplication of the cube by the conchoid. I happened to come across a solution of the latter in an old book, Leslie's "Geometrical Analysis" (1821), where the problem is solved also in several other ways—by means of the cissoid, two parabolas, a rectangular hyperbola and circle, and the logarithmic curve. The problem of the trisection of an angle is also solved in several ways—by means of the conchoid (two ways), an hyperbola ($e = 2$) and intersecting circle, a rectangular hyperbola and circle, the quadratrix, the companion to the cycloid, and the Archimedean spiral, but *not* by the cissoid.

The problem of the duplication of the cube is solved in the following way by the conchoid.

Let AB, AC be the two given lines placed at right angles. Complete the rectangle AD and circumscribe a circle about it. Then if through C a line ECG be drawn cutting BD, BA produced in E and G and the circle again in H, and making EC = HG, it is known that AG and DE are the two mean proportionals between AC and AB. (Philo's construction.) Bisect BD at F, and on AB describe an isosceles triangle having BK = AK = BF. Join KG.

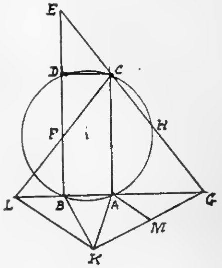

FIG. 1.

Then $ED \cdot EB = EC \cdot EH = GH \cdot GC = GA \cdot GB$,
$\therefore GA \cdot GB + BF^2 = ED \cdot EB + BF^2 = EF^2$;
and $GK^2 = AK^2 + GA \cdot GB = EF^2$, $\therefore GK = EF$.

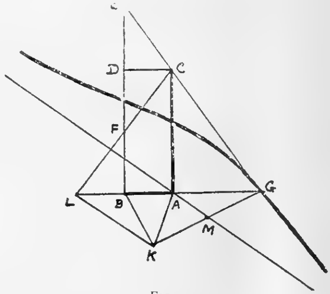

FIG. 2.

Join CF meeting AB produced in L, join LK and draw AM ∥ LK.

Then $LA = 2AB$, and $ED : BA = CA : AG$
$\therefore 2DE : AC = 2AB : AG = AL : AG$
$\therefore AL : AG = DE : DF$, $\therefore EF : DF = LG : AG$
$= GK : GM$; but $EF = GK$, $\therefore GM = DF = \frac{1}{2}AC$.

We have then the following construction.

With K as pole, AM as asymptote, and ½AC as the constant distance, describe a branch of a conchoid on the farther side of AM. Let BA cut the curve in G, then AG is the first, and KM the second mean proportional between AC and AB.

I have not been able to find any more recent accounts, but perhaps some others of your readers can tell whether the cissoid has been employed to trisect an angle, or whether it is possible to solve the problem by means of this curve. An easy solution, which is not given in Leslie's book, would be by means of the Limaçon, $r=a(1+2\cos\theta)$. D. M. Y. SOMMERVILLE.

24 Balhousie Street, Perth, August 24.

Auroræ and Meteors.

ON Tuesday, September 10, a beautiful display of the curtain Aurora Borealis was observed here at 9.30 p.m. It extended from the northern horizon to about 12°, and from north-by-east to north-north-west. The most brilliant part of the display lasted for about ten minutes after we first observed it, and then dissolved into a diffused, though vivid, glow. At 10.20 p.m. the Aurora was evidently much more distant, exhibiting itself as a brilliant glow above the north-western horizon.

At 9.52 p.m., the same evening, a brilliant meteor was observed darting towards the south-west, the line of motion passing between Corona Borealis and Hercules. The maximum brilliancy of the meteor was superior to that of Jupiter. At 10.45 p.m. a meteor was observed darting past Arcturus, which was then about 3° above the north-by-west point of the horizon. At 10.50 p.m. (Greenwich time) a brilliant meteor darted from a point within 1° of α Persei in a westerly direction, leaving a broad streak.

ALEX. C. HENDERSON.

The Manse, Rusness, Sanday, September 11.

THE INVERNESS EARTHQUAKE OF SEPTEMBER 18.

THE earthquakes of the Inverness district rank among the strongest ever felt in this country, but we must go back nearly a century to find one that surpassed the recent shock in intensity and extent of disturbed area. That of August 13, 1816, of which Sir T. Dick Lauder's brief but graphic account is the chief memorial left to us,[1] damaged several buildings in Inverness, and was felt over the whole of Scotland. After this, no shock of much consequence occurred until that of February 2, 1888, which was felt so far as Edinburgh and Glasgow and was perceptible over a district the area of which is estimated at about 15,000 square miles.[2] The earthquake of November 15, 1890, was slighter still; buildings were practically uninjured by it, and its disturbed area did not exceed 7500 square miles.[3] In all three cases the epicentre lay close to Inverness and not far from the northern boundary fault of the Highland district, and it is, therefore, natural that movements along this fault or system of faults should be held responsible for the origin of the earthquakes.

The shock of last week occurred shortly before 1.30 a.m., and thus it is possible that we may never know the full extent of its disturbed area. It does not seem to have been noticed in either Edinburgh or Glasgow, but the southern limit of the area cannot have lain many miles north of the line joining these cities, for the shock was certainly felt along the south coast of Fifeshire. Most of the rest of Scotland must have been sensibly shaken, for we have records from places as far north as Wick, in the west of Mull, and all along the east coast of Aberdeenshire.

In Inverness the damage, though never serious, is considerable in amount. There is scarcely a street in the town which has entirely escaped. In a few houses, chimney-stacks or parts of them fell down, and many chimney-cans were overthrown or displaced. For some miles round the town similar slight damage occurred. At Dochgarroch, about four miles south-west of Inverness, a long crack was formed in the north bank of the Caledonian canal. It is in the middle of the towing-path, in the hard-packed surface, and is nearly half an inch wide and about 600 yards long.

From the accounts which have appeared in the newspapers and from a few which I have already received, it is possible to draw roughly an isoseismal line corresponding to the degree 7 of the Rossi-Forel scale. This is in the form of an ellipse, with its longer axis parallel to the great fault and with the larger part of the curve lying on the south-east side of the fault. As the fault hades in this direction, it is exceedingly probable that a slip along it at no great depth gave rise to the recent earthquake.

The stronger Inverness earthquakes generally occur without the warning of preliminary shocks, but are followed for some time by weaker movements. Three at least occurred on the morning of the 18th, and it is not unlikely that for another month or so slight shocks may be felt in and around Inverness before the earth's crust there is once more brought to rest.

CHARLES DAVISON.

1 Quoted by D. Milne, *Edin. New Phil. Journ.*, vol. xxxi. 1841, pp. 116-117.
2 C. A. Stevenson, *Edin. Roy. Soc. Proc.*, 1888, pp. 260-266.
3 *Quart. Journ. Geol. Soc.*, vol. xlvii. 1891, pp. 618-632.

DR. J. L. W. THUDICUM.

THE death of Dr. Thudicum removes from our midst the living equivalent of a very familiar name. As a worker, to the younger generation of men of science he was not known, but some of his numerous communications upon topics extraordinarily varied can scarcely have escaped the observation, and have most probably received the serious attention, of almost every one interested in the medical sciences. More than half a century ago he graduated in medicine at Giessen. Almost immediately afterwards, stimulated by the work and magic influence of the great Liebig, who had attracted to the quiet and secluded university a bevy of young men eager to become adept in methods which, in the hands of their great master, had forced Nature to yield up truths of such momentous importance to physiology, Thudicum began to work at physiological chemistry.

Shortly afterwards he settled in this country, took a medical qualification and began to practise. It must be admitted that he established himself in London at an opportune moment. The application of exact chemical method to physiological, and certainly to pathological, phenomena was then in its infancy. The pupil of Liebig, trained in the methods of the Giessen laboratory and possessed of a practical knowledge of disease, had acres of virgin soil to cultivate. His power was soon appreciated; in 1856 he became physician to the St. Pancras Dispensary, and in 1858 lecturer to the Grosvenor Place School of Medicine. In 1865 he was appointed lecturer on pathological chemistry at St. Thomas' Hospital and director of a newly founded chemical and pathological laboratory there, obviously a position with immense opportunities.

His studies soon received official recognition, in that Sir John Simon, the principal medical officer to the Privy Council, engaged him in 1864 to undertake a series of researches upon pathological chemistry. Thudicum's results were embodied in reports which were published as appendices to the reports of the medical officers of the Privy Council and Local Government Board, and continued to appear at various dates down to 1882. Although no doubt a mass of constant work was embodied in these reports, they were not so fruitful in practical results as was anticipated, or perhaps it would be fairer to say, the tremendous achievements shortly afterwards of bacteriology in this department o hygiene, rendered them relatively insignificant. Further, these reports gave rise to a very considerable polemic, other workers in this field not accepting Thudicum's results, or, *a fortiori*, the theories founded upon them.

In 1871 Dr. Thudicum published conjointly with Dr. Dupré his most copious work, a book of 700 odd pages, on the origin, nature and varieties of wine. His views upon this subject have also not received general acceptance. In 1872 he published a manual of chemical physiology. His last work of note appeared in 1886 and consisted of a treatise on the chemical constitution of the brain.

Although Thudicum's life-study must be regarded as physiological chemistry, he from time to time wrote upon exclusively practical medical subjects, *inter alia* diseases of the nose, the curative value of electricity in medicine, &c., and consistently with this he made and kept together a large medical practice, being successful as a physician and greatly esteemed by his patients.

Thudicum's mind was one of problems, and whenever a problem esented itself to him he did his best—often, it is true, with imperfect methods—to solve it; even if, as in many cases must be admitted, his work has not yielded results of first importance, by his death medical science has lost at least an honest and indefatigable investigator and many men and women a sincere friend.

NOTES.

THE profound grief expressed by the British Association when news of the assassination of the late President of the United States was received, was described in last week's NATURE. We have now received a copy of the letter sent to Mr. Choate, the American Ambassador, by Prof. Rücker, president of the Association, and of the reply. The letter sent was as follows:—"To his Excellency the Hon. J. H. Choate, Ambassador of the United States of America. Sir,—The General Committee of the British Association for the Advancement of Science, assembled this year in Glasgow, desire me to express to you the horror with which they heard of the attack upon the late President of the United States, and their deep sorrow at his death. On the first day of the meeting in Glasgow the Association telegraphed to Mr. McKinley the assurance of their sympathy and of their earnest hopes for his recovery. These hopes have not been fulfilled, and it is now my sad duty to inform you that the tragic fate of the President of the United States has cast a deep shadow over our meeting. Together with all our fellow countrymen we share in the sorrow of the great sister-nation which you represent; and we desire, through you, to inform the men of science of America that the members of the British Association are bound to them not only by ties of blood, not only by the links which unite all students of Nature, but by the deeper feelings which draw together those who are partners in a common sorrow, and mourn one of the leaders of our common race.—I am, sir, your obedient servant, A. W. Rücker." In reply, the American Ambassador wrote:—"Sir,—I have received with heartfelt gratitude the kind expression of condolence and sympathy at the death of President McKinley which you have forwarded to me on behalf of the General Committee of the British Association for the Advancement of Science. I shall duly advise my Government of its receipt, and it will be highly appreciated by them and by Mrs. McKinley. Your kind message and hundreds of other similar communications from all parts of the British Dominions, carry an assurance of national friendship and goodwill which will be most welcome to the American people.—Yours sincerely, Joseph H. Choate."

MANY men of science will sympathise with Dr. Henry Woodward, F.R.S., at the sad death of his younger son, Mr. Martin Fountain Woodward, demonstrator in biology, Royal College of Science, South Kensington, London. Mr. Woodward was drowned on the night of September 15 by the capsizing of a boat at Moyard, near Letterfrack, co. Galway, Ireland, where he was in charge of the Marine Biological Laboratory of the Fisheries Board for Ireland, during the long vacation. He was in his thirty-sixth year.

DR. A. C. HADDON, F.R.S., sailed by the *Campania* on September 21 for a ten weeks' visit to the United States, for the purpose of studying the ethnological museums and the methods of instruction and research in ethnology in the States.

THE Swiney lectures this year will be delivered by Dr. J. S. Flett, on the "Geological Evidences of Former Geographical Conditions." The lectures will be delivered at the Victoria and Albert Museum, South Kensington, and will commence on Monday, October 7.

THE programme of the National Home-Reading Union for the thirteenth reading session, 1901–1902, includes nature-study among the subjects upon which advice will be given as to suitable books to read, and helpful articles will be contributed to the Society's magazine. Nature is, of course, the best teacher, but books are valuable in directing attention to her attractions. The address of the Society is Surrey House, Victoria Embankment, London, W.C.

WE regret to record the death of Dr. Edward Waller Claypole, B.A., F.G.S., of the Throop Polytechnic Institute, California, and previously professor at Antioch College, Yellow Springs, and at Buchtel College, Akron, in Ohio. In 1878 he drew attention to the discovery of the oldest known fossil tree from the Upper Silurian of Eaton, Ohio, and he named the specimen *Glyptodendron eatonense*. Since that date he contributed many papers to American journals on the geology and palæontology of the United States, giving a good deal of attento fossil fishes, but dealing with all branches of geological investigation.

ON Sunday, September 22, a solemn festival was held in the small Swedish island of Hveen. The occasion was the approaching 300th anniversary of the death of Tycho Brahe, the celebrated astronomer, who lived and worked on the island and spent his happiest years there. The festival was held among the few remains of Brahe's once imposing observatory at Uranienborg. The Copenhagen correspondent of the *Times* states that, early in the morning, guests from Denmark and Sweden, including representatives of the Universities, arrived in steamers. Outside the small harbour the Swedish ship *Drott* was at anchor with King Oscar on board. The King landed with the other guests and drove to Uranienborg. After Divine service, conducted by Bishop Billing, of Sweden, Dr. Hillebrandt, of Sweden, delivered a long speech, ending with the following words:—"We congratulate Denmark upon the never-dying memory of this man. This spot is now Swedish; therefore the King of Sweden is here to-day to honour the memory of Denmark's great and noble son." The party then walked through the ruins, which were decorated with the Swedish and Danish flags. The monument of Tycho Brahe, erected by Swedes, was decorated with the Danish colours.

PROF. ENGLER has returned from the Canary Islands with a large collection of plants for the Botanical Garden and Museum at Berlin.

MR. T. MEEHAN has an interesting paper, in the *Proceedings* of the Academy of Natural Sciences of Philadelphia, on the bending of branches in mature trees. The "weeping" habit is, according to him, always the result of diminished vitality in the tree.

IN the *International Bulletin* of the Academy of Sciences of Cracow (1901, No. 4), Godlewski and Polzeniusz have an exhaustive paper (in German) on the intramolecular respiration and production of alcohol in seeds placed in water. They conclude that the chemical processes which take place in the respiration of plants are not uniform, but may vary in different circumstances. In a general way they agree very closely with the process of fermentation.

AN International Conference on Plant Breeding and Hybridisation, to be held at New York in the autumn of 1902, is announced by the Horticultural Society of New York. The provisional programme includes the following papers, among others:—Results of hybridisation and plant breeding in Canada, by Mr. W. Saunders; notes on plant breeding in California, by Mr. E. J. Wickson; plant breeding in New Jersey, by Prof. B. D. Halsted; hybrid plums, by Mr. F. A. Waugh; variations in hybrids not appearing in the first generation, but later, by Mr. E. S. Goff; orchid hybrids, by Mr. Oakes Ames; cytological aspects of hybrids, by Mr. W. A. Cannon, Columbia University, New York City.

THE Bureau of Plant Industry of the United States Department of Agriculture has been entirely reorganised. The work has been divided into various groups, viz.:—Vegetable pathological and physiological investigations; botanical investigations and experiments; pomological investigations; grass and forage-plant investigations; experimental gardens and grounds; Arlington experimental farm; Congressional seed distribution; seed and plant introduction; tea culture experiments. Each class of investigations has its own laboratory, in charge of a skilled expert; the chief of the Bureau and head physiologist and pathologist is Prof. B. T. Galloway.

THE Reale Istituto Veneto announces nine prizes for competition in the faculties of science, letters and arts, for which essays have to be sent in at the close of the years 1901, 1902, 1903. The subjects in science include the projective properties of the two-dimensional algebraic surfaces of n dimensional space, the geophysical and biological characters of the lakes of the Venetian district excluding the Lago di Garda, and the development of the respiratory apparatus of the pulmonate vertebrata.

IN the *Physical Review* for August, Mr. Martin D. Atkins discusses the polarisation and internal resistance of electric cells. The object of the paper, of which a further part is promised, is to examine the two questions, firstly, is the change in the resistance of an electrolytic cell with varying currents a real or an apparent change? and, secondly, does the Wiederburg theory with its derived formulæ satisfy the known conditions and the characteristic curves of this change?

A SERIES of observations on the effects of Becquerel, Röntgen and other rays on the eye are detailed by Messrs. Himstedt and Nagel in the *Berichte* of the Freiburg Naturalists' Society (1901). The fact that such action exists was pointed out by Giesel. In the present investigations it is shown that the effects are in many cases largely due to fluorescence of neighbouring bodies, but that the rays appear to directly affect the rods of the retina. The authors also examined the effects of Röntgen rays and those from an incandescent lamp on the electromotive force set up in the eye of a frog, and the effects of the two kinds of rays are very similar.

WE have received a reprint of M. Guillaume's report communicated last year to the Physical Congress on the transitory deformations of solids. These variations, which differ from those attributed to elasticity or plasticity, are produced either by changes of temperature or by mechanical means, and M. Guillaume has studied them both in glass and in nickel steel. The author finds that the phenomena are governed by comparatively simple laws, and he considers that they may probably be attributed to variations in the chemical equilibrium of the molecules. The effects of the deformations in question in connection with the variations in thermometers render this subject one of practical interest.

THE Meteorological Society of Mauritius has commenced the issue of a new series of *Proceedings* and *Transactions*. Vol. i. embraces the five years 1896–1900, and contains a number of useful papers read before the Society—mostly drawn up by the secretary, and relating chiefly to the rainfall and cyclones in the South Indian Ocean. From want of funds and other causes no volume of *Transactions* has appeared since the year 1854, and it is pointed out in the preface to the present volume that whatever the Society may have accomplished in the past has been due, in a great measure, to the untiring energy of the late Dr. Meldrum, who contributed many papers on the law of storms; two of his investigations, on the form of cyclones and an atlas showing the cyclone tracks of the Southern Indian Ocean, have been included among the publications of the Meteorological Council. The present honorary secretary of the Society is Mr. T. F. Claxton.

WE have received a copy of a Report on the meteorological observations made at the Abbassia Observatory, Cairo, during the years 1898 and 1899, together with the mean results derived from the observations of the previous thirty years, prepared under the superintendence of Captain H. G. Lyons, R.E., Director-General of the Survey Department. In 1859, the Khedive ordered the reestablishment of the observatory which had existed from 1845–50 at Bulaq, but had then been closed; the site was not selected until 1865, and the series of regular observations only commenced in 1868. The observatory is situated about three miles north-north-east of Cairo, on the edge of the desert. Meteorological observations have been made every three hours, and magnetic observations have been taken recently, as frequently as the staff available for the purpose could be spared. In 1889, Mr. J. Barois published a very complete discussion of the climate of Cairo, and his tables have been used in the present report. All the observations have been made directly by the observers, but commencing with the year 1900, a complete set of self-recording apparatus has been brought into operation. The volume is accompanied by twenty-two plates showing the mean daily and annual variations of all elements; these greatly enhance the utility of the work, and show at a glance the general results derived from the detailed tabular statements, which are given in French measures. The discussion is a very valuable contribution to meteorological science, and both tables and plates are very carefully prepared and plainly printed.

THE October pilot chart of the North Atlantic and Mediterranean, just issued by the Meteorological Office, shows that during August and the early part of September there were scores of icebergs on the Belle Isle steamer route, from the 48th to the 56th meridian. One observer counted seventy-seven, another one hundred bergs, another described them as innumerable. Great numbers of them were very large, ranging up to a mile long and 200 feet high. No field ice was reported, but there were numerous low flat pieces of ice almost awash and dangerous to navigation. Some bergs were also fallen in with in the neighbourhood of the Flemish Cap, and a solitary one had wandered away to the south-westward of the Bank of Newfoundland to 43° N., 53° W. October witnesses a decided increase in the frequency and the strength of the gales experienced over the northern portion of the Atlantic, and in the remarks on the inset cyclonic type chart it is stated that during some part of the month, usually in about the middle, very severe gales are almost invariably experienced over the British Isles. Some of the most violent West Indian hurricanes on record have occurred in this month. It has been found convenient to divide the October tropical storms into two classes—those which are experienced during the existence of high barometric pressure over the Eastern States of America, and those when these anticyclones are away to the north or north-west. In the former case the hurricanes originate far out on the ocean, and their centres seldom pass to the westward of the 75th meridian, sometimes, indeed, their point of curvature is even so far to the eastward as 41° W., the mean path curving in 67° W. In the latter case most of the storms are developed about the Gulf of Mexico or the western end of the Caribbean Sea, and in their passage northward and north-eastward cling to the American coast, some a little way inland, others not far out at sea. Unlike the hurricanes of July, August and September, the distinguishing feature of the October ones is that they make comparatively little westing in the early stages of their career, their prevailing tendency being to draw away to the northward almost immediately after their formation, a fact which must be associated with the seasonal change in the disposition of pressure over America. The winds of the Adriatic, including the Bora and the Sirocco, are separately dealt with.

IN the *Zoologist* for September the Editor, Mr. W. L. Distant, inaugurates a discussion on "Animal Sense Perceptions," in the course of which he hints that colour-perception among the lower animals may be very different to our own, and consequently that we should be cautious in regarding many types of animal coloration as protective. Mr. E. Selous, in continuing his observations on the habits of the great crested grebe, hazards some very remarkable speculations.

IT was noted some months ago in this journal that an archaic type of arachnid from Texas belonging to the genus Kœnenia had been identified with the Sicilian *K. mirabilis*. Fuller comparison has enabled Miss A. Rucker to state in the *American Naturalist* for August that, as might have been expected, it turns out to be distinct. The genus has also been discovered in Siam and Paraguay, so that, like most archaic types, it is probably cosmopolitan. The material now available admits of the definition of the ordinal group to which this strange form belongs.

FROM the Smithsonian Institution we have received a copy of a paper by Messrs. Jordan and Snyder on the apodal or eel-like fishes of Japan, forming *Bulletin* No. 1239 of the U.S. Museum. The authors recognise two ordinal groups of these fishes, the one including the "rice-field eels" (Monopterus), and the other the true eels, congers and murænas. Many excellent illustrations are given, and a considerable number of new species described. For one genus the name Echidna is employed, and if this usage be correct the egg-laying mammal so designated requires a new title. In the British Museum Catalogue of Marsupials and Monotremes, Mr. O. Thomas definitely stated, however, that, as regards the eel, Echidna is a *nomen nudum*. The question should be decided one way or the other.

THE *Biologisches Centralblatt* of September 15 contains an account of Dr. K. Hescheler's investigations into the affinities of Pleurotomaria, that handsome genus of gastropod molluscs of which so few survivors now remain. Although the author confirms previous conclusions as to the generally primitive character of this genus, he finds that this does not hold good for all parts of its anatomy, which displays certain evidences of specialisation. In another communication Dr. Walkhoff contrasts the human lower jaw with that of the inferior Primates, in the course of which he points out that the celebrated "Naulette jaw" approximates to the modern type in a much greater degree than is the case with the one from Schipka, which is the oldest at present known.

TWO memoirs on development constitute the contents of the September issue of the *Quarterly Journal of Microscopical Science*. In the one Mr. J. G. Kerr continues his account of the developmental history of the South American lung-fish (*Lepidosiren paradoxa*), the first portion of which was published in the *Phil. Trans.* The author finds that both in this genus and the allied African Protopterus the early development is remarkably like that of the tailed amphibians, while it also resembles that of the lampreys, and rather less closely that of the so-called ganoid fishes. In the second article—illustrated with five double plates—Mr. R. Evans discusses in great detail the development of the Malayan representatives of peripatus, the description of which has been already noticed in these columns.

MR. ARTHUR SMITH, the curator of the Natural History Museum at Grimsby, is making a collection of notes and records of alien plants which occur in Britain, and asks the cooperation of local botanists.

MR. H. L. LYON reprints from the *Minnesota Botanical Studies* a paper entitled "Observations on the Embryology of *Nelumbo*," showing that both in its anatomy and in its embryology *Nelumbo* conforms to the type of the Monocotyledons. He derives from this the conclusion that the order Nymphæaceæ should be removed from the Dicotyledons and should be placed among Monocotyledons in the series Helobiæ.

IT is stated in the January-March 1901 issue of the Kew *Bulletin of Miscellaneous Information*, which has just reached us, that in consequence of the extreme pressure of the demands of important Government work the publication of the *Bulletin* had for a time to be suspended. Its issue has, however, now been resumed. The present number is almost entirely devoted to "a list of the contributors to the Herbarium of the Royal Botanic Gardens, Kew, brought down to December 31, 1899." The volume of the *Bulletin* for 1899 has also reached us. Its contents have been referred to in our "Notes" from time to time as the serial has appeared.

WE have received the Report of the Directors of the Botanical Survey of India for the year 1900-1901, also the Annual Report of the Royal Botanic Garden, Calcutta, for the year 1900-1901, and that of the Government Cinchona Plantation and Factory in Bengal for the year 1899-1900. In his report of the Royal Botanic Garden, Calcutta, the superintendent, Major Prain, speaks of the serious damage done by the excessive rainfall in the autumn of 1900, amounting to 40½ inches from the 19th to the 25th of September, 13⅓ inches having fallen on September 20. Although there was no wind, many trees were uprooted, and a large number of others died after the rain had ceased and they were exposed to sunshine. The Cinchona plantations were also greatly damaged by a disastrous rainstorm which passed over the Darjeeling district on the night of September 24-25, 1899. The most recent publication of the Botanical Survey of India (vol. i. No. 13) is the report of a botanical tour in the South Lushai Hills by Lieut. A. T. Gage.

THE Royal Horticultural Society has made a new departure in the August number of its *Journal*, in the form of "Notes on Recent Research." The design is to give in each issue an abstract or short digest of the papers of botanical, and especially of horticultural, interest in the leading British, Colonial, American, and Continental botanical journals. Of these abstracts several very good samples are given in the present number, the most important being a summary of Engler's valuable paper on plant distribution in the Alps. The abstracts from current horticultural periodicals occupy nearly fifty pages. Independently of these abstracts, the current number of the *Journal* is a very interesting one. Now that the phenomena of hybridisation are attracting so much attention, all students of the subject will be grateful to the editor for giving a full translation of Herr Gregor Mendel's much-quoted paper on "Experiments in Plant Hybridisation," published in 1865 in the *Abhandlungen des naturforschenden Vereines* in Brünn. The translator, Mr. W. Bateson, in an introductory note, gives the following as the chief outcome of Mendel's experiments:—"The proof that, in certain pairs of differentiating characters, the germ-cells of a hybrid, or cross-breed, are pure, being carriers and transmitters of either the one character or the other, not both." Other articles of interest in this bulky number are:—"Woad, a Prehistoric Pigment," by Dr. Plowright; "Wild Gardens," by H. S. Leonard; "Hybrid Conifers," by Dr. Masters; and others of special interest to horticulturists.

MRS. E. S. ARMITAGE read an interesting paper on some Yorkshire earthworks, before the British Association at Bradford, which has recently been published, with illustrations, in *The Reliquary and Illustrated Archaeologist* (vol. vii., July 1901, p. 158). The author holds that the very numerous artificial hillocks usually surrounded by a ditch and bank are not British, Roman, Scandinavian, or Saxon, as they have so often been described, but that they are Norman *mottes* which were protected round the top by a stockade and crowned with a wooden tower, the *bretarche* or *donjon*. These earthern castles were the local pivots which carried the action of the central machinery of Norman organisation into the remotest parts of the kingdom and thus established feudalism all over England.

AMONG the local *fêtes* of parts of the north of France the procession of giants forms the most original and picturesque custom. Each Flemish town formerly possessed its giant, but this curious custom preserves its ancient ceremonial in only a few localities. Lille has not seen for a long time the procession of the giant "Phinar," which was vilified as was its colleague "Annéen" at Valenciennes. The festivals of giants are still preserved at Dunkirk, where "Papa-Rœusse" is the idol of the inhabitants, at Cassel, at Gand, at Brussels, and especially at Douai, where every June "Gayant" has a triumphal procession accompanied by his wife, "Marie Cageon," and their three children, "Jacquot," "Fillon" and "Bimbin." An illustrated account of this interesting survival, by Paul Diffloth, will be found in *Cosmos* (Nouv. Série, No. 867, 1901, p. 292). A further account is given by Father R. P. Delattre of a Punic necropolis near Sainte-Monique, Senegal, West Africa. The numerous objects that are figured are deposited in the museum at Saint-Louis. This important investigation deserves the attention of English archæologists who are interested in the Mediterranean peoples.

THE Tuesday evening science lectures at the Royal Victoria Hall will commence on October 8, when Dr. A. Smith Woodward, F.R.S., will lecture on "Bone Digging in Greece." A lecture on "Photography in Natural Colours" will be given by Mr. J. W. Hinchley on October 15.

THE address delivered by M. E. T. Hamy, president of the French Association for the Advancement of Science, at the recent meeting at Ajaccio, appears in the *Revue Scientifique* of September 14. The subject is "Les debuts de l'anthropologie en France."

A LIST of second-hand electrical instruments and accessories and other apparatus required in laboratories has been sent to us by Mr. G. Bowron, Edgware Road, London. Teachers requiring efficient apparatus at a low cost, for lecture or laboratory purposes, might consult the list with advantage.

A COPY of the eighth annual report of the Church Society for the Promotion of Kindness to Animals has been received. The Society is distinguished from the generality of similar organisations in the fact that it directs attention to such subjects as the neglect of wounded war horses, the sufferings endured by horses used for war purposes, the carelessness and sickening brutality often exhibited in the slaughtering of animals, bearing reins, cruelty to wild animals in captivity, spurious sports, "angling" for song birds, and other cruelties to animals usually regarded with indifference. Many people are willing to assist the efforts of a society working in this direction who are unable to see why animals should not be inoculated in order to extend the means of alleviating human suffering. The office of the Society is at Church House, Westminster.

WE congratulate the authorities of the Government Museum of Madras on the Catalogue of the Prehistoric Antiquities, by R. Bruce Foote, which has just been published by the Superintendent of the Government Press, Madras, for the moderate sum of eight shillings. The catalogue is terse, and is illustrated by thirty-four plates of excellent photographic reproductions of some 225 objects and one plate of ownership marks on Iron-age pottery. It appears that there is in India a decided break between the Palæolithic and Neolithic ages, but in Southern India there is no gap in time between the Neolithic and Iron ages, the people of the latter age being doubtless direct descendants of the former. A few bronze, brass and copper implements and ornaments have been found, but apparently none as yet under circumstances showing distinctly that they preceded the Iron age. The existence of a distinct bronze or copper age may then, for the present, be regarded as quite problematic for South India. The pride of the Madras collection is unquestionably the great series brought together by the late Mr. James Wilkinson Breeks during his very successful exploration of the Nilgiri cairns and barrows while holding the post of Commissioner of those hills. A few palæoliths are figured, but no Neolithic implements or pottery. The Iron age is well illustrated in pottery and implements; one beautiful bronze vase of classical form and decorated with flutings and lotus designs deserves special mention. The archaic costumes of the figurines indicate that the art of iron smelting and working became known in India fully three thousand years ago, if not more.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. W. Openshaw; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by the Rev. E. P. Green; a Collared Peccary (*Dicotyles tajaçu*, ♂), a Ring-tailed Coati (*Nasua rufa*, ♀) from South America, presented by Mr. F. G. Newton, C.M.G.; a Ring-tailed Coati (*Nasua rufa*, ♀) from South America, two Punctated Agoutis (*Dasyprocta punctata*) from Central America, presented by Captain R. G. Taylor; a Hedgehog (*Erinaceus europaeus*), British, presented by Mr. C. J. Murray; a Fulvous-breasted Pied Woodpecker (*Dendrocopus macii*), two Jungle Babblers (*Crateropus canorus*), an Indian Cuckoo (*Cuculus micropterus*), a Pied Crested Cuckoo (*Coccystes jacobinus*), a Pied Ground Thrush (*Geocichla wardi*), a Crimson-breasted Barbet (*Xantholaema haematocephala*) from British India, presented by Mr. E. W. Harper; five Vipers (*Vipera berus*), British, presented by Mr. A. Old; a White-crowned Mangabey (*Cercocebus aethiops*) from West Africa, a Pigmy Marmoset (*Hapale pygmaea*) from the Upper Amazons, a Red-headed Marsh Bird (*Agelaeus ruficapillus*), two Black Tanagers (*Tachyphonus melaleucus*) from South America, a Yellow Sparrow (*Passer luteus*) from East Africa, an Indian Roller (*Coracias indica*) from India, two Gigantic Salamanders (*Megalobatrachus maximus*) from Japan, an Indian Elephant (*Elephas indicus*, ♀) from India, deposited; a Crab-eating Opossum (*Didelphys cancrivorus*) from Tropical America, purchased; an Altai Deer (*Cervus eustephanus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN OCTOBER.

Oct. 1. 11h. 14m. to 11h. 53m. Moon occults B.A.C. 1240 (mag. 5·7).
3. 17h. 10m. to 18h. 9m. Moon occults 71 Orionis (mag. 5·1).
11. 11h. 2m. Minimum of Algol (β Persei).
13. Ceres 7′ S. of γ Ceti (mag. 3).
13. 7h. Venus in conjunction with δ Scorpii. Venus 10′ N.
14. 7h. 51m. Minimum of Algol (β Persei).
15. Venus. Illuminated portion of disc = 0·705.
15. Mars. Illuminated portion of disc = 0·951.
17. 5h. 2m. to 5h. 38m. Moon occults ξ Ophiuchi (mag. 4·5).
19–21. Epoch of the Orionid meteors (radiant 91° + 15°).
22. 9h. 5m. to 9h. 7m. Moon occults c' Capricorni (mag. 5·2).
23. 4h. 44m. to 7h. 38m. Transit of Jupiter's Sat. IV.
23. 8h. 53m. to 10h. 6m. Moon occults κ Aquarii (mag. 5·5).
24. 14h. 35m. to 15h. 30m. Moon occults λ Piscium (mag. 4·7).
27. 2h. 25m. to 4h. 6m. Partial eclipse of the moon. Our satellite will rise at 4h. 35m., 29m. after the earth's shadow has passed off her disc, but the penumbra will remain until 5h. 26m., though it will be observed with difficulty.
28. Ceres in opposition to the sun (Ceres, mag. 7·4).
31. 12h. 44m. Minimum of Algol (β Persei).

FIREBALL OF SEPTEMBER 14, 1901.—Mr. W. F. Denning writes:—

"One of those brilliant fireballs which often appear suddenly in the early part of the night, and for a few seconds illumine the sky and landscape, was seen by many persons in various parts of the country on September 14 at about 8h. 44m. It was especially bright over the western part of England, and people in South Wales and North Devon obtained a fine view of the phenomenon. As seen from these parts, the fireball was many times brighter than Venus, and it moved with moderate slowness, leaving a strong trail or train of sparks, which, however, quickly died out. The head was bluish-white, and it seemed to plough its way through the atmosphere with an irregular motion and fluctuating light, as though strongly resisted.

"The fireball was well observed at Manchester, Wallingford (Berks), Chiddingfold (Surrey), Bristol and many other stations. The direction of its flight from the best descriptions was from between the constellations Aquarius and Pegasus, the radiant being at 345° + 1° near the star β Piscium. The height of the meteor when first seen was 66 miles vertically over a point 6 miles N.E. of Ilfracombe, North Devon, and when last seen the height was about 26 miles over a point in the sea 3 miles N.W. of St. David's Head, Pembrokeshire. The length of path was 83 miles and velocity about 20 miles per second. Possibly the path may have been longer and the object may have approached to within about 23 miles of the earth's surface, but the observations are not quite accordant. It is to be hoped that further descriptions of this splendid object will be forthcoming, so that the real path may be very accurately ascertained.

"On September 14, 1875, at 8h. 27½m., a large fireball passed over the eastern counties of England, falling from a height of 63 to 14 miles and directed from a radiant at 348° ± 0°. Lieut.-Colonel Tupman computed the real path from twelve accordant observations, and there is no doubt that this brilliant object, which appeared exactly twenty-six years ago, belonged to the same system as that which furnished the recent fireball. Apart from the large meteors which are often directed from it, the radiant is well defined every year from ordinary shooting stars, and it appears that its chief activity is displayed during the months of August and September."

NEW VARIABLE STAR 77, 1901, HERCULIS.—Dr. T. D. Anderson announces that he has detected variability in the star B.D. + 7°·3199, the position of which is

R.A. = 16h. 25m. 49·7s.
Decl. = + 7 8′·9.

Some years ago it was estimated to be about the ninth magnitude, while on August 19 and 21 it was invisible in a 3-inch finder with which tenth magnitude stars were easily visible.

THE GLASGOW MEETING OF THE BRITISH ASSOCIATION.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY HUGH ROBERT MILL, D.SC., LL.D., F.R.S.E., F.R.G.S., PRESIDENT OF THE SECTION.

On Research in Geographical Science.

Introductory.

THE annual reassembling of friends and fellow-workers in the old re-visited towns, and the annual accession of new lovers of science, furnish a unique opportunity for a survey of the advances made in each department, a fitting occasion also for remembering those who have finished their work and can aid our deliberations only by the memory of their example.

Apart from our more intimate losses in the death of many distinguished geographers and devoted workers, the period since our last meeting has been for all a year of mourning. The passing of the nineteenth century was almost like the death of a friend, and it is still difficult to realise that the century which we had been so long in the habit of associating with everything new and great and progressive has itself become part of the past. Few coincidences have been more striking than the almost simultaneous close of that unparalleled reign which gave a name to the Era including all that was best and most characteristic of the century. The death of Queen Victoria carried so keen a sense of personal loss into every heart that few attempts have been made to show how vast a portion of the stream of time—measured by progress—intervened between the terminal dates of her life. Think for a moment of the splendid advances in the one small department of geographical exploration during the late Queen's reign, the multitude of landmarks which have been crowned by the great name of Victoria—of the Earth's most southerly land and its most northerly sea, of the largest lake and most majestic waterfall of Africa, the loftiest lake of Asia, the highest peak in New Guinea, the widest desert and most populous colony in Australia, and of the two thriving seaports on either side of the North Pacific which couple together the British Dominions of western America and eastern Asia.

What could be more appropriate in this first meeting after the close of such a century and of such a reign than to pass in brief but appreciative review the advances of geography during those hundred or those sixty-five years? One thing in my opinion is more appropriate than to dwell on past triumphs or to regret past greatness, and that is to survey our present position and look ahead. In the first year of a new century and of a new reign we are reminded that we have a future to face and that the world is before us, and I propose to seize this opportunity in order to speak of the science of geography as it is now understood and especially to urge the importance of the more systematic pursuit of geographical research henceforward.

Geography in the Universities.

The prospect of immediate expansion in many British universities seems at last likely to afford more than one opportunity of wiping out the old disgrace of the neglect of geographical science in the accredited seats of learning. Already Oxford has a well-manned School of Geography, and Cambridge has a Reader in Geography. The reconstituted University of London occupies the best position in the world for creating a chair of geographical research, situated as it is in the very centre of the comings and goings of all mankind, and in touch with the most complete geographical library and map-collection in existence. The new University of Birmingham may, it is hoped, prove better than its promises, and may perhaps after all provide some more adequate treatment of geography than its proposed partition amongst the professors of half a dozen special subjects, all of them concerned in geography, it is true, but none of them individually, nor all of them collectively, capable of embodying that coordination of parts into a harmonious unity which gives to geography its power as a mental discipline and its value for practical application. But England in all that pertains to higher education is still a poor country, and the will to do well is hampered by the grinning demon of poverty. Here, on the other side of the Border, we are in a different atmosphere. The wave of the magician's wand in the hands of Andrew Carnegie has brought wealth that last year would have been deemed fabulous to the ancient universities in Scotland, and it will be a disgrace to our country if this splendid generosity does not result in the establishment of one or more fully endowed and completely equipped chairs of geography.

There may still be some people who view geography as the concern only of soldiers and sailors, adventurous travellers, and perhaps of elementary teachers. Exploration is undoubtedly the first duty of geographers, but it is a duty which has been well done, the nineteenth century having left us only one problem of the first magnitude. This is the exploration of the polar regions, and even here the twentieth century clamours for new methods.

The Antarctic Expeditions.

This year has seen the long-hoped-for Antarctic expeditions set out on their great quest, a quest not only of new lands in the southern ice-world but of scientific information regarding all the conditions of the vast unknown region. Two expeditions have been planned in Great Britain and Germany with a complete interchange of information regarding equipment and methods of work. Provision has been made for simultaneous magnetic and meteorological observations, and in some instances for the use of instruments of identical construction, and all possibility of any unseemly rivalry in striving for the childish distinction of getting farthest south has been obviated by the friendly understanding that the British ship shall explore the already fairly known Ross quadrant, where it is pretty sure that extensive and accessible land will favour exploration by sledges, while the Germans have chosen the entirely unknown area of the Enderby quadrant which no ice-protected steamer has yet attempted to penetrate, and where they enter a region of potential discovery before they cross the Antarctic circle.

The British expedition is equipped on the good old plan that produced such fine results in the days of Cook and Ross; it is manned by sailors of the Royal Navy and is under the command of a gallant naval officer, though, unlike the earlier vessels, the *Discovery* is not herself a naval ship. As in the days of Cook the naval officers are assisted in their non-professional work by several young and promising scientific men, two of whom have already had experience of work in the polar regions. These have the great advantage of the counsel and help of Mr. George Murray, of the British Museum, who goes as far as Melbourne in the position of Director of the Scientific staff.

No one who has seen the zeal and unflagging enthusiasm with which Sir Clements Markham has organised the expedition can hesitate to accord to him in fullest measure the credit for its successful inauguration. And no one who has seen the quiet and good-humoured determination of the commander, Captain R. F. Scott, in overcoming many irritating preliminary difficulties, can doubt his fitness to undertake the heavy responsibilities of the voyage. I at least am sure that he will be a worthy successor to Cook, Ross, Franklin, Nares, and all the other officers who have made their names and the name of the British Navy famous in polar service. The second in command, Lieutenant Armitage, R.N.R., has had several years of Arctic experience, and amongst the crew there are some old whalers whose knowledge of the ways of sea-ice should prove of value. The ship and her equipment are unique; it is no exaggeration to say that she is the best-found and most comfortable vessel which has ever left our shores on a voyage of discovery.

The German expedition has been more boldly planned than ours. It is new and experimental all through, as befits a young nation in its first exuberant efforts in a new field. If some people suppose that it may have made mistakes that our expedition has avoided, these, at least, are new mistakes from which new lessons are to be learned. If risks must be run—and we of the twentieth century are, I trust, no more timid of incurring risks than our predecessors of the nineteenth, or the eighteenth, or even the seventeenth—it is good that they should be new risks. To scientific men in Germany it appears natural and reasonable that a man of science should be the head of a scientific expedition; and that a geographer should lead a geographical expedition. Many British men of science sympathise in this view. Dr. Erich von Drygalski, one of the professors of Geography in the University of Berlin, has been entrusted with the command to which he was appointed before the ship was designed, and for five years he has given all his time and thought to the expedition. He is supported by a band of highly trained specialists, who have spared neither time nor travel in mastering the subjects with which they may deal, and each has also received a general training in the subjects of all his colleagues—an admirable precaution. The captain of the *Gauss*, who belongs to the Merchant Service, has taken a course of training from the Norwegian whalers off Spitsbergen. He will, of course, be absolute master of the ship and crew in all that concerns order and safety, but he will be under the direction of the leader in all that concerns the plan of the voyage and the execution of scientific work. This arrangement is one which has always seemed to me to be desirable, that the captain of a ship on scientific service should occupy a position in relation to the scientific chief similar to that of the captain of a yacht in relation to the owner; but it is subject to the drawback that a naval officer could not well be asked to accept such a divided command.

But whatever our views as to ideal organisation may be, we are all certain that both expeditions will do the utmost that they can to justify the confidence that is placed in them and to bring honour to their flags. We know that the officers and staff of the *Discovery* belong to a race which, whether trained in the University or in the Navy, has acquired the habit of bringing back splendid results from any quest that is undertaken.

A Definition of Geography.

The bright prospects of Antarctic Exploration must not, however, blind us to the fact that exploration is not geography, nor is the reading or even the writing of text-books, nor is the making of maps, despite the recognition of leading cartographers as "Geographers to the King." These are amongst the departments of geography, but the whole is greater than its parts.

The view of the scope and content of Geography which I have arrived at as the result of much work and some little reading during twenty years is substantially that held by most modern geographers. But it is right to point out that the mode of expressing it may not be accepted without amendment by any of the recognised leaders of the science, and for my own part I believe that discussion rather than acceptance is the best fate that can befall any attempt at stating scientific truth.

Put in the fewest words, my opinion is that

Geography is the science which deals with the forms of relief of the Earth's crust, and with the influence which these forms exercise on the distribution of all other phenomena.

This definition looks to the form and composition of the Earth's crust itself, and to the successive coverings, partial and complete, in which the stony globe is wrapped. We sometimes hear of the New Geography, but I think it is more profitable to consider the present position of Geography as the outcome of the thought and labours of an unbroken chain of workers, continuously modified by the growth of knowledge, yet old in aim, old even in the expression of many of the ideas that we are apt to consider the most modern.

Some Historical Landmarks.

Claudius Ptolemæus, about 150 A.D., gathered into his great "Geography" the whole outcome of the Greek study of the habitable world. He laid stress on the threefold nature of descriptions of the Earth's surface, the general sketch of the great features of the world alone receiving the name of Geography, the more special description of an area he termed Chorography, and the detailed account of a particular place Topography.

Aristotle, who first adduced real proofs of the sphericity of the Earth, had not failed to note the relationships which exist between plants and animals, and the places in which they are found, and he argued that the character of peoples was influenced by the land in which they lived; but Ptolemy cared little for theories, comparisons, or relationships, confining himself rather to the record of actual facts. He made errors, the results of which were more important, as it happened, in advancing knowledge than were the truths which he recorded; for after the troubled mediæval sleep, when even the spherical form of the Earth was blotted out of the knowledge of Christendom, the scientific deductions made by Toscanelli from the false premises of Ptolemy heartened Columbus for his westward voyage to the Indies, on the very outset of which he stumbled all unknowing on the New World. When Magellan succeeded in the enterprise which Columbus had commenced, the fourteen centuries' reign of Ptolemy in geography came to an end; his work was done.

The rapid unveiling of the Earth in the sixteenth and seventeenth centuries cast a glamour over feats of exploration which has not yet been wholly dissipated, and it may not be easy, even now, to obtain wide credence for the fact that the explorer is usually but the collector of raw material for the geographer.

It is of vital interest to trace the re-formation of the theory of geography after its interruption in the Middle Ages. The fragments of the old Greek lore were cemented together by new and plastic thoughts, crudely enough by Apian, Gemma Frisius, and Sebastian Munster in the sixteenth century, but with increasing strength and completeness by Cluverius, Carpenter, and Varenius in the seventeenth.

The First Oxford Geographer.

The names of Cluverius and Varenius are familiar to every historian of geography, but that of Carpenter, I am afraid, is now brought to the notice of many geographical students for the first time. He was not so great as Varenius, but he was the first British geographer to write on theoretical geography as distinguished from mathematical treatises on navigation or the repetition of narratives of travel, and I think that there is evidence to show that his work had an influence on his great Dutch contemporary.

Nathanael Carpenter, Fellow of Exeter College, Oxford, published his book in 1625 under the title—

"Geographie delineated forth in two Bookes. Containing the Sphericall and Topicall parts thereof," and with the motto from Ecclesiastes on its title-page—

"One generation commeth, and another goeth, but the Earth remayneth for ever."

The great merits of Carpenter's treatise are his firm grasp of the relation of one part of geography to another, his skilful blending of the solid part of the work of Aristotle and Ptolemy with that of the explorers and investigators of his own generation, and the wholesome common-sense that dominates his reasoning. His definition is comprehensive and precise.

"Geographie is a science which teacheth the description of the whole Earth. The Nature of *Geographie* is well expressed in the name: For *Geographie* resolved according to the *Greeke* Etymologie signifieth as much as a description of the Earth; so that it differs from *Cosmographie*, as a part from the whole. Forasmuch as *Cosmographie* according to the name is a description of the whole world, comprehending under it as well *Geographie* as *Astronomie*. Howbeit, I confesse, that amongst the ancient Writers, *Cosmographie* has been taken for one and the self-same science with *Geographie* as may appeare by sundry treatises meerely Geographicall, yet intituled by the name of *Cosmographie.*"

The differences held by Ptolemy to distinguish geography from chorography Carpenter shows to be merely accidental, not essential, and as to geography he says "It is properly tearmed a *Science*, because it proposeth to it selfe no other end but knowledge; whereas those faculties are commonly tearmed *Arts*, which are not contented with a bare knowledge or speculation, but are directed to some farther work or action. But here a doubt seems to arise, whether this *Science* be to be esteemed *Physicall* or *Mathematicall*? Wee answer, that in a Science two things are to bee considered: first, the *matter* or object whereabout it is conversant; secondly, the *manner* of handling and explication: For the former no doubt can bee made but that the object in *Geographie* is for the most part *Physicall* consisting of the parts whereof the Spheare is composed; but for the manner of Explication it is not *pure* but *mixt*; as in the former part *Mathematicall*, in the second rather *Historicall*; whence the whole Science may be alike tearmed both *Mathematicall* and *Historicall*; not in respect of the *subject* which we have said to be *Physicall* but in the manner of *Explication.*"

Although somewhat diffuse in expression, the meaning of these statements is clear and sound, and to the British public as new now as it was in the days of King Charles. The book treats of mathematical geography and cartography, of magnetism, climates, the nature of places, of hydrography, including the sea, rivers, lakes and fountains, of mountains, valleys and woods, of islands and continents, and at considerable length of people and the way in which they are influenced by the land in which they live. Whether Dr. Carpenter lectured on geography in Oxford I do not know, but his book must have acquired a certain currency, for a second edition appeared in 1635, and it seems probable that it was known to Varenius.

Varenius and Newton.

Varenius, a young man who died at twenty-eight, produced in Latin a single small volume published in 1650, which is a model of conciseness of expression and logical arrangement well worthy even now of literal translation into English. So highly was it thought of at the time that Sir Isaac Newton brought out an annotated Latin edition at Cambridge in 1672.[1] The opening definition as rendered in the English translation of 1733 (a work spoilt in most places by a parasitic growth of notes and interpolations) runs:—

"Geography is that part of *mixed mathematics* which explains the state of the earth and of its parts, depending on quantity, viz. its figure, place, magnitude and motion with the celestial appearances, &c. By some it is taken in too limited a sense, for a bare description of the several countries; and by others too extensively, who along with such a description would have their political constitution."

Varenius produced a framework of Physical Geography capable of including new facts of discovery as they arose, and it is no wonder that his work, although but a part, ruled unchallenged as the standard text-book of pure geography for more than a century. He laid stress on the causes and effects of phenomena as well as the mere fact of their occurrence, and he clearly recognised the vast importance upon different distributions of the vertical relief of the land. He did not treat of human relations in geography, but, under protest, gave a scheme for discussing them as a concession to popular demands.

Kant.

As Isaac Newton, the mathematician, had turned his attention to geography at Cambridge in the earlier part of the eighteenth century, so Immanuel Kant, the philosopher, lectured on the same subject at Königsberg in the later part. The fame of Kant as a metaphysician has defrauded him of much of the honour that is his due as a man of science. As Prof. Hastie puts it: "His earlier scientific work, like an inner planet merged in light, was thus almost entirely lost sight of in the blaze of his later philosophical splendour."

Kant, it will be remembered, considered that the communication of experience from one person to another fell into two categories, the historical and the geographical: that is to say, descriptions in order of time or in order of space. The science of geography he considered to be fundamentally physical, but physical geography formed the introduction and key to all other possible geographies, of which he enumerated five: *mathematical*, concerned with the form, size, and movements of the earth and its place in the solar system; *moral*, taking account of the customs and characters of mankind according to their physical surroundings; *political*, concerning the divisions of the land into the territories of organised governments; *mercantile*, or, as we now call it, commercial geography; and *theological*, which took account of the distribution of religions. It is not so much the cleavage of geography into five branches, all springing from physical geography like the fingers from a hand, which is worthy of remark, but rather the recognition of the interaction of the conditions of physical geography with all other geographical conditions. The scheme of geography thus acquired a unity and a flexibility which it had not previously attained, but Kant's views have never received wide recognition. If his geographical lectures have been translated no English or French edition has come under my notice, and such currency as they obtained in Germany was checked by the more concrete and brilliant work of Humboldt, and the teleological system elaborated in overwhelming detail by Ritter.

The teleological views of Ritter were substantially those of Paley. The world, he found, fitted its inhabitants so well that it was obviously made for them down to the minutest detail. The theory was one peculiarly acceptable in the early decades of the nineteenth century, and it had the immensely important result of leading men to view the earth as a great unit with all its parts coordinated to one end. It gave a philosophical, we may even say a theological, character to the study of geography.

Kant's views had pointed to such a unity, but from another side, that of evolution. It was not till after Charles Darwin had fully restored the doctrine of evolution to modern thought that it was forced upon thinking men that the fitness of the earth to its inhabitants might result, not from its being made for them, but from their having been shaped by it. It is certain that the influence of the terrestrial environment upon the life of

[1] Dugdale, in the introduction to the English translation published in 1733, states explicitly that Newton produced his version for the benefit of the students attending his lectures "on the same subject" from the Lucasian chair; but we have been unable to find any more satisfactory evidence that Newton actually lectured on geography at Cambridge.

a people has been carried too far by some writers—by Buckle, in his "History of Civilisation," for example—but it is no less certain that this influence is a potent one.

The Nature of Geography.

Granted that such influence is exercised, some objectors may urge that geography has nothing to do with the matter, and we are compelled to acknowledge that the meaning and contents of geography are in this country as variously interpreted as the colour of the chameleon in the traveller's tale. Yet my thesis is that it is just this relation between the forms of the solid crust of the Earth and all the other phenomena of the surface that constitutes the very essence of geography.

It is a fact that many branches of the study of the Earth's surface which were included in the cosmography of the sixteenth century, the physiography of Linnæus, the physical geography of Humboldt, and perhaps even the *Erdkunde* of Ritter, have been elaborated by specialists into studies which, for their full comprehension, require the whole attention of the student. Geology, meteorology, oceanography and anthropology, for example, have been successively specialised out of geography; but it does not follow that these specialisations fully occupy the place of geography, for that place is to coordinate and correlate all the special facts concerned so that they may throw light on the plan and the processes of the Earth and its inhabitants. Geography, in fact, is concerned with the results, not with the processes of the special sciences, and the limits between geography and geology, to take a single instance, are to be drawn, not between any one class of phenomena and another, but between one way and another of marshalling and utilising the same facts. This was clear to Carpenter in 1625, though we have almost forgotten both it and him.

The Principles of Geography.

The principles of geography—the "pleasant principles," to use the phrase of old William Cuningham in 1559—on which its claims to status as a science rest are generally agreed upon by modern geographers, though with such variations as arise from differences of standpoint and of mental process. The evolutionary idea is unifying geography as it has unified biology, and the whole complicated subject may be presented as the result of continuous progressive change brought about and guided by the influence of external conditions. These views have been often expressed in recent years, but they do not seem to have been very seriously considered, and no excuse need be offered for presenting them once more, though in an epitome curt to baldness.

The science of geography is of course based on the mathematical properties of a rotating sphere; but if we define geography as the exact and organised knowledge of the distribution of phenomena on the surface of the Earth, we see the force of Kant's classification, which subordinated mathematical to physical geography. The vertical relief of the Earth's crust shows us the grand and fundamental contrast between the oceanic hollow and the continental ridges; and the hydrosphere is so guided by gravitation as to fill the hollow and rise upon the slopes of the ridges to a height depending on its volume, thus introducing the great superficial separation into land and sea. The movements of the water of the ocean are guided in every particular by the relief of the sea-bed and the configuration of the coast lines. Even the distribution of the atmosphere over the Earth's surface is affected by the relief of the crust, the direction and force of the winds being largely dominated by the form of the land over which they blow. The different physical constitution of land, water and air, especially the great difference between the specific heat and conductivity or diathermancy of the three, causes changes in the distribution of the sun's heat, and as a result the simple climatic zones and rhythmic seasons of the mathematical sphere are distorted out of all their primitive simplicity. The whole irregular distribution of rainfall and aridity, of permanent, seasonable and variable winds, of sea-climate and land-climate, is the resultant of the guiding action of land forms on the air and water currents, disturbed in this way from their primitive theoretical circulation. So far we see the surface forms of the Earth, themselves largely the result of the action of climatic forces, and constantly undergoing change in a definite direction, controlling the two great systems of fluid circulation. These in turn control the distribution of plants and animals, in conjunction with the direct action of surface relief, the natural regions and climatic belts dictating the distribution of living creatures. A more complicated state of things is found when the combined physical and biological environment is studied in its incidence on the distribution of the human race, the areas of human settlement, and the lines of human communications. The complication arises partly from the fact that each of the successive earlier environments acts both independently and collectively; but the difficulty is in greater degree due to the circumstance that man alone amongst animals is capable of reacting on his environment and deliberately modifying the conditions which control him.

It seems to me that the glory of geography as a science, the fascination of geography as a study, and the value of geography in practical affairs are all due to the recognition of this unifying influence of surface relief in controlling, though in the higher developments rather by suggestion than dictation, the incidence of every mobile distribution on the Earth's surface.

The Classification of Geography.

Following out this idea, we are led to a classification of the field of geography in a natural order, in which every department arises out of the preceding with no absolute line of demarcation, and merges into the succeeding in the same way. This classification, it is necessary to note, is not like a series of pigeon-holes, which may be placed in any arbitrary order, but like a chain, in which the succession of the links is essential and unalterable.

Since form and dimension are the first and fundamental concepts in geography, the first and basal division is the *Mathematical.* Mathematical geography leaves the Earth as a spinning ball lighted and warmed according to a rigid succession of diurnal and annual changes. This merges into the domain of *Physical Geography*, which involves the results of contemporary change in the crust and the circulation of the fluid envelopes, with the resulting modifications in the simple and predictable mathematical distributions. This division falls naturally into three parts: Geomorphology, dealing with the forms of the solid crust and the changes they are undergoing at the present time; Oceanography, dealing with the great masses of water in the world; and Climatology, dealing with the effects of solar energy in the air. But all three spheres—lithosphere, hydrosphere, and atmosphere—are so closely inter-related that no one of them can be studied without some preliminary knowledge of the others. This forms the largest and most important part of geography, more varied and intricate than the mathematical, better known and more definite than those involving life.

Bio-geography, the geographical distribution of life, arises directly from physical geography, which dominates it, but it is full of complex questions which involve the biological nature of the organism and the influence of physical environment, in which geographical elements, although predominant, do not act alone. Difficult as some of the problems of the distribution of life are at the present day, the remains of living creatures found fossil in the rocks, and the survivors of archaic forms still lingering in remote islands, supply us with our only instrument of research into the geography of past ages, often making it possible to lay down the areas of land and water in earlier geological periods.

The relation of man to the surface of the Earth detaches itself from the rest of Bio-geography by the number of exceptions to general laws of distribution and by the human power of modifying environment. It has necessarily been formed into a special department, *Anthropo-geography.* In primitive man the control exercised by environment is nearly as complete and simple as in the case of the lower animals; but with every advance in culture fresh complications are introduced. The relation of people to the land they inhabit, the choice of sites for dwellings and towns, the planning and carrying into effect of lines of communication, are all obviously much under the control of land form and climate. When people get settled in a favourable position they usually become attached to it; they acquire, one may say, the colour of the land, in modes of thought as well as in manner of life. The poems of Ossian and the Crofter Question require for their elucidation a knowledge of the geographical conditions of the Western Highlands, just as the Border ballads and the Border raids were largely conditioned by the geography of the Southern Uplands.

Attachment to the native valley or the native fields leads to the holding of land by clans or tribes and the fusion of tribes into nations, while changes in physical conditions stimulating migration from a deteriorating country may lead to the invasion of settled territories by homeless hordes. Here Anthropo-geography buds off the subdivision of *Political Geography*, which takes account of the artificial boundaries separating or sub-dividing countries, and of the innumerable artificial restrictions and ameliorations which are superimposed on the natural barriers and channels of intercommunication. Even in political geography only a humble place is held by a statement of boundaries and capitals, to lists of which the great name of Geography has actually been confined by people who ought to have known better.

Anthropo-geography views the world from the standpoint of the race, political geography from the standpoint of the nation; but room has to be found for a yet more restricted outlook, that of the individual, whose view of the world as it profits himself is known as commercial geography. This department deals with natural commodities and their interchange, and perhaps because here rather than in the other departments a successful comprehension of the inter-relation of cause and effect may be, in the language of the schoolroom, "reduced to pounds, shillings and pence," the name of Applied Geography has been proposed. It fitly terminates our survey of the science, for the flickering disturbances of the equilibrium of supply and demand known simultaneously over the whole world, and the slower movements of transport to restore equilibrium, are still far from the power of scientific prevision, and all we can do at present is to point out certain clear lines of least resistance, or greatest advantage, due to the interactions of natural and human causes and effects.

To sum up in a sentence the field and the function of geography in the broad majesty of its completeness, we may say that it is the description of the surface of the solid Earth as it is in itself, as it acts upon the ocean, the air, and the living things which inhabit it, and as it is affected in turn by their actions.

Geography and the State.

Viewed thus, I believe that geography will be found to afford an important clue to the solution of every problem affecting the mutual relations of land and people, enlightening the course of history, anticipating the trend of political movements, indicating the direction of sound industrial and commercial development.

It would be possible, unfortunately it would be easy, to enumerate misconceptions of history, blunders in boundary settlements, errors in foreign policy, useless and wasteful wars, mistakes in legislation, failures in commercial enterprise, lost opportunities in every sphere, which are due to the neglect of such a theoretical geography. Surely it is to the laws defining the interaction of Nature and Man that we should turn for guidance in such affairs rather than to the dull old British doctrine of "muddling through." That vaunted process after all means that we are driven by stress of facts to do without intending it or knowing how, and at immense expense, the very things that intelligent study beforehand would have shown to be necessary, feasible and cheap.

All this has been urged again and again, and it has fallen on the ears of those in authority "like a tale of little meaning, though the words are strong." I admit that all advocates of a rational geography have not escaped the danger of the special pleader—they have promised too much. If a Government official were to say, "Yes, I confess there was a mistake here, the affair was managed badly, much money and some prestige were lost; it must all be done over again; please tell me how," I am afraid that the chances are that the answer would be vague, general and unpractical. If the answer to this boldly hypothetical question is ever to be clear and definite, geography must be studied as it has never yet been studied in this country. It must pass beyond the stage of a pastime for retired officers, colonial officials and persons of leisure, and become the object of intense whole-hearted and original study by men of no less ability who are willing to devote, not their leisure, but their whole time to the work. The object of geographical research should be nothing less than the demonstration or refutation of what we claim to be the central principle of geography—that the forms of terrestrial relief control all mobile distributions.

A Projected Geographical Description.

In order to focus the question it may be convenient to consider the geography—or chorography, as Ptolemy would have termed it—of the British Islands. No author has ever attempted to give such a description. Camden's "Britannia" was swamped by archæology; the county histories, which are certainly not deficient in number, were wrecked outward bound on the harbour-bar of genealogy. Sir John Sinclair's old "Statistical Account of Scotland" in the intelligent utilisation of very incomplete data was a great but solitary stride in the right direction. Bartholomew's great "Atlas of Scotland" supplies the cartographical basis for a modern description of the northern kingdom; but the description itself has not been undertaken on an equal scale. The work of producing a complete geographical description of the British Islands would be gigantic, but not hopelessly difficult.

The material has been collected at an enormous expenditure of public money, and is stacked more or less accessibly, much of it well-seasoned, some I fear spoilt by keeping; but there it lies in overwhelming abundance, heaps of building materials, but requiring the labour of the builder before it can become a building.

There is first and chief the Ordnance Survey, one of the grandest pieces of work in mathematical geography that has ever been accomplished. The result is a series of maps almost as perfect as one can expect any human work to be, showing in a variety of scales from ¼ of an inch to 25 inches to a mile every feature of the configuration of the land—except the lake-beds.

There is next the hydrographic survey by the Admiralty, giving every detail of the subaqueous configuration in and around our islands—except the lake-beds.

These two great surveys supply the basis for a complete description of the British Islands, and the geological survey, which in a sense is more elaborate than either of the others, completes the fundamental part. The geological map makes it possible to explain many of the forms of the land by referring to the structure of the rocks which compose them. Both the geological and hydrographic surveys are accompanied by memoirs describing the features and discussing the various questions arising from the character of each sheet; but there is nothing of the kind for the maps of the ordnance survey.

The ordnance maps show at the date of their preparation the extent and also the nature of the woodlands and moorlands, and this information is supplemented by the Returns of the Board of Agriculture, which each year contain the statistics of farm crops, waste land, and livestock for every county. These returns are excellently edited from the statistical point of view, but they are not discussed geographically. It is easy to see in any year how much wheat is raised in each county, but it is a slow and laborious process to discover from the Returns what are the chief wheat-growing areas of the country. The county is too large a unit for geographical study, as it usually includes many types of land form and of geological formation. Before the distribution of crops can be understood or compared with the features of the ground they must be broken up into parishes, or even smaller units, and the results placed on maps and generalised. The vast labour of collecting and printing the data is undertaken by Government, and paid for by the people without a murmur, but the geographer is left in ignorance for the want of a comparatively cheap and simple cartographic representation of the facts.

The Inspector of Mines and the Board of Trade publish statistics of the industry and the commerce of the country, statistically excellent, no doubt, but in most cases lacking the cartographic expression which makes it possible to take in the general state of the country from year to year. The same is true of the Registrar-General's Returns of births, marriages, and deaths, in themselves an admirable epitome of the health conditions of the country, and of the fluctuations in population, but limited by a narrow specialism to the one purpose.

Finally and chiefly we have the Census Reports. Once in ten years the people are numbered and described by sex, age and occupation. The inhabited houses are numbered, and the smaller dwellings grouped according to size. The figures are most elaborately classified and discussed, so as to bring out the distribution of population, and its change from the previous decade. But to the geographer the Census Reports are like a cornfield to a seeker of bread. The grains must be gathered, prepared, and elaborated before the desired result is obtained. Nowhere is the cartographic method more useful than here. It is a striking contrast to turn to the splendid volumes of the United States Census Reports, many of them statistically inferior to ours, but thickly illustrated with maps, showing at a glance the distribution of every condition which is dealt with, and enabling one to follow decade by decade the progressive development of the country, and to study for each census the relations between the various conditions.

These are only a few of the statistical publications, produced by Government, and embodying year after year a mass of conscientious labour, which, save for a few specialists who extract and utilise what concerns themselves, is annually "cast as rubbish to the void."

One small department supported by public money, but under unofficial direction, may be referred to as an example of the successful employment of cartographic methods. This is the Meteorological Council, appointed by the Royal Society, and charged with the collection of meteorological data and the publication of weather reports, forecasts, and storm warnings. The maps published twice daily to show the distribution of atmospheric pressure and temperature are only rough sketches and very much generalised, yet they serve the purpose of presenting the facts in a graphic form, yielding at a glance information which could only be extracted from tables by long and laborious efforts. The pilot charts, published monthly by the same department, showing the average conditions of air and sea over the whole North Atlantic, and the occasional atlases of oceanographical data are valuable geographical material.

The official work of Government is supplemented by the voluntary labours of many societies, in whose transactions much valuable material is stored, and in not a few cases is admirably discussed. But even with these supplements gaps remain which must be filled by private enterprise before a complete geographical description can be compiled.

Considering the Ordnance Survey alone it is hardly credible and not at all creditable that the Treasury should veto the extension of the survey to the lake-beds on the score of expense, yet such is the fact. The directors of the Survey have shown themselves ready to encourage private workers by placing the data presented by them upon the maps with due acknowledgment.

The Survey of the Lakes.

It is with profound satisfaction that I now make an announcement—by special favour the first public announcement—of a scheme of geographical research on a national scale by private enterprise. Sir John Murray and Mr. Laurence Pullar have resolved to complete the bathymetrical survey of all the fresh-water lakes of the British Islands. Mr. Laurence Pullar will take an active part in the proposed survey, and has made over to trustees a sum of money sufficient to enable the investigation to be commenced forthwith and to be carried through in a comprehensive and thorough manner. It is intended to make the finished work an appropriate and worthy memorial of Mr. Pullar's son, the late Mr. Fred Pullar, who had entered enthusiastically upon the survey of the lochs of Scotland, and whose heroic death while endeavouring to save life in Airthrey Loch last February must be present to the memory of many of you. Large sums of money devoted in good faith to scientific purposes do not always bring about the wished-for result; but in this case there is no room for anxiety on that score. Sir John Murray, with whom Mr. Fred Pullar had worked for several years, has generously promised to direct the whole scheme, and to be responsible for carrying it out. All the lakes of the British Islands will be sounded and mapped as a preliminary to the complete limnological investigation which is proposed. The nature of the deposits, the chemical composition of the water and its dissolved gases, the rainfall of the drainage areas, the volumes of the inflowing and outflowing streams, the fluctuations in the level of the surface, the seasonal changes of temperature, and the nature and distribution of aquatic plants and animals will all receive attention. The geological history of the lakes may also be inquired into with reference to such points as the growth of deltas, the erosion of the margins, and, perhaps, the conditions of the old dead lakes that are now level meadows.

Five years at least will be required to make these observations and to incorporate them in memoirs, each of which will be a complete natural history of the lakes of one river basin. The proposed work wants more than money, direction and time. It requires the services of several young and enthusiastic workers—preferably men who have completed their University course and are anxious to devote some time to research. Sir John Murray and Mr. Pullar wish to meet three or four capable young fellows, one preferably a chemist, one a geologist, one a botanist, and one a zoologist. When found they will be offered a salary sufficient to enable them to give their whole time to the work, but not large enough to induce anyone who has not the love of science at heart to take it up. From my experience when working in somewhat similar conditions at the Scottish Marine Station seventeen years ago, I can promise those who will have the good fortune to be selected plenty of hard work for which they will get the fullest credit—and this they will appreciate more keenly when they come to know the world better—and I can promise them also in their association with Sir John Murray a course of scientific and intellectual training such as even the universities do not afford.

Other Desirable Surveys.

The Geological Map requires to be supplemented by additional work on the nature of the superficial soil as it affects agriculture, such as is expressed in the *Cartes agronomiques* of France, going more fully into the chemical nature of the soil than is possible on the Drift Maps of the Survey which so usefully supplement the maps of solid geology. Such experiments as have been made at the College at Reading in collecting analyses of the soils in the neighbourhood might very well be carried out at the agricultural colleges and other centres all over the country. It would form an invaluable supplement to the work of the Government geologists.

Of equal value, though, perhaps, more obviously so to the scientific than to the "practical" man, is the study of the natural vegetation of the country. In a highly cultivated land like ours there are comparatively few places where the native flora remains in possession, but the mapping of the main crops which have supplanted it is nearly as useful. To become satisfactory from this point of view, the statistics of the Board of Agriculture ought to be supplemented by surveys made by trained botanists on the ground. A valuable beginning has been made under the ever-fertile stimulus of Prof. Patrick Geddes in the two sheets of a map of the plant-associations of Scotland compiled by the late Robert Smith, whose premature death last year was a loss to science. It would be a splendid thing if this map could be finished as a memorial to the brilliant young botanist in the same way as the survey of the lakes is proposed as a memorial worthy of Fred Pullar, and I am glad to learn that there is some probability of it being carried on.

Of all the other distributions which might be worked out cartographically time fails us to speak; but reference must be made, however briefly, to a few.

Geography of the Air.

With regard to Meteorology, the distribution of temperature and pressure over the British Islands for the year and for the separate months have been worked out by the experienced hand of Dr. Buchan and published both in separate memoirs and in the "Meteorological Atlas," edited by Dr. Buchan and Dr. Herbertson. But such observations as the degree of cloud or of sunshine can as yet be treated only in a superficial and generalised way for want of data. Perhaps the most important and certainly the most difficult of all the atmospheric conditions to discuss fully is precipitation. It depends on so many varying conditions, such as the form and exposure of the land, the altitude above sea-level, the direction and force of the wind, the relative frequency of thunderstorms, the distance from the sea, the direction of the average paths of cyclonic storms, &c., that far more numerous and more long-continued observations are required to establish the normal condition of the country than in the case of either temperature or pressure. When we reflect that the whole water-supply of the country depends directly on rainfall, and when we remember that the value of water-power made available by differences of level promises to be greater in the future than it has been in the past, we can see that a study of rainfall in conjunction with configuration may prove as valuable for the localisation of the manufacturing centres of the future as the geological survey was for those of the present.

Thanks to the remarkable foresight and the untiring exertions of the late Mr. Symons, the volunteer rainfall observers of this country have been encouraged to organise their efforts, and by working on a common plan have accumulated within the last forty years a mass of observations unrivalled for number and completeness in any other land. But as yet the difficulties in the way of constructing a map of normal rainfall on an adequate scale have not been overcome, and much experimental work will probably be necessary before it can be accomplished. To this task it is my ambition to devote myself. I may be permitted to state that Scotland is far behind England or Wales in the number of rainfall stations per square mile. Thus there is, roughly, one rain-observing station for every 20 square miles of England, one for every 30 square miles of Wales, but only one for every 67 square miles of Scotland, and one for every 170 square miles of Ireland.

Rainfall observations only tell the amount of available water; the configuration of the stream-beds must be considered in determining water-power. The only country I know where the horse-power of the rivers has been measured and mapped is Finland, but of course individual rivers, such as the Mississippi, Rhine, Seine, and Thames, have been thoroughly studied. Before many decades have passed it will be a necessary element in the surveys of all countries, though at present the available data are few and scattered.

Population Maps.

In considering human geography we come to the most interesting and least occupied field of research. Until Mr. Bosse constructed his beautiful maps of the density of population of Scotland and England we had absolutely no cartographical representation of the true distribution of people over the land. To map population by counties gives a very poor idea of the truth, for in such counties as Yorkshire or Perthshire there are large areas entirely without inhabitants, and small areas where the population is very dense. Mr. Bosse's maps were made on the principle of leaving blank all the land on which there were no dwelling houses, and so obtaining a close approximation to the true density of population of the inhabited area. For Scotland his map shows at once that it is a function of configuration. It shows the densely peopled lowland plain, the less densely peopled coast-strip surrounding the country, and the least densely peopled valleys running inland into the great uninhabited areas. The population map of England, on the other hand, shows an absolutely startling relation to the geological structure, which in turn is closely related to the configuration. We are not astonished to see the centres of densest population coinciding with the Coal Measures, but it is both surprising and instructive to see how the density of population runs parallel to the strike of the Secondary and Tertiary rocks of south-eastern England, a band of the lightest population following each outcrop of chalk and limestone, a band of dense population following each belt of sandstone or clay.

Anthropo-geography teems with fascinating subjects of research. The admirable investigations in the West of Ireland on the physical anthropology of the people might well be extended to the whole country outside the great towns, where all evidence of place of origin and original character is speedily lost. Good work has been done in this way by the Ethnographic Survey promoted by a committee of this Association, and a committee of the Royal Scottish Geographical Society has rendered great aid to the Ordnance Survey in the cognate study of the place-names of Scotland.

The distribution of religion, even in the three typical forms of Anglican, Presbyterian, and Roman Catholic—forms so typical as to be, broadly speaking, national—is most imperfectly known. The objection to a religious census is one which is somewhat difficult of comprehension in Scotland, and too polemic for sober discussion in England. But a few of the problems are worth being worked out by individuals. The curious islands of Roman Catholic continuity in Lancashire, the Hebrides and the Highlands can probably be related simply enough to the configuration of the country and the means of communication as influencing free movement of people at critical periods of history. There are many interesting points as to the geographical distribution of surnames, the relation of characteristic literature or poetry to specific areas, things small in themselves, but capable of exercising very far-reaching influence if systematically worked out.

Geographical Synthesis.

Granted that the subsidiary surveys have been made and the results put in a strictly comparable form, the central problem remains—the synthesis of the complete geography of the country. This can perhaps be solved best by comparing the maps of the various distributions in the proper order, and seeing how far they are related to one another. For the general discussion the Ordnance Map on the scale of one inch to a mile should be used, and each natural region ought properly to be treated by itself, but as a matter of practical convenience it would probably be found best to select either the artificial boundaries of counties or the still more arbitrary lines bounding sheets of the map. Whatever small area is taken as the unit of description, it should be treated in such a way as to seek for and prove or disprove the existence of any control exercised by the form of the land and its geological character on the outcrops of the rocks, the nature of the soil, the course of the rivers, the temperature and movements of the air, the rainfall, the vegetation and agriculture, the distribution of population, the sites of towns, villages, and isolated dwellings, the roads, railways and harbours, the birth-rate and death-rate, and on the progressive changes in all these conditions which are shown in the discussion of the statistics collected annually or decennially. When such unit areas are worked out individually the results can easily be combined and condensed into a geographical description that will be complete, well balanced, and symmetrical. The work is practicable; it requires only time, money, direction and workers to carry it out; but although a specimen memoir, prepared by the authority of the Royal Geographical Society, met with a certain measure of approval, all attempts failed to obtain funds for making the work complete, and the scheme must await a more educated generation before it can be profitably revived in its entirety. But meanwhile this field for geographical study and research lies at the doors of every University where the subject is or may be recognised, and the labours of professors and students might be profitably directed to the completion of such memoirs for the surrounding district, gradually working further and further afield. The idea is no more new than every other "thing under the sun." Such exercises, not so elaborately planned, but the same in essentials, were ordinary subjects for theses in the universities of Sweden and Finland during the eighteenth century. To come nearer home, the local handbooks prepared for successive meetings of the British Association are frequently very fair examples of the geographical description of a district. The essential qualities are rarer in guide-books, but we must not forget one brilliant exception, the poet Wordsworth's "Guide to the English Lakes."

It is pleasant to hear that through the encouragement of Sir John Murray the Scottish Natural History Society is taking up the systematic study of the basin of the Forth, and they will, I feel sure, give a good account of their labours. One point which must be very strongly emphasised is that a geographical treatise is distinguished from a jumble of facts mainly by the order and proportion in which the phenomena are dealt with, and by the relation of cause and effect that is established between them.

As to the utility of complete geographical descriptions, we must of course recognise their greater practical importance in new and developing countries than in old lands like our own. Yet even with us the study of the distribution of natural resources may suggest important changes, involving great redistributions of population.

A Geographical Warning.

Hitherto, except as regards exploration and cartography, the position of geography in this country has never been satisfactory. Times are changing, and even in exploration we are now only one amongst many rivals, often better equipped by education, usually in no way deficient in daring. Although the best work of several of our cartographers in Edinburgh and London need fear no comparison, we cannot conceal the fact that Germany leads the world in map-making. As regards the recognition or even the comprehension of geography by the State, by the universities and by the public, we are equally far behind our neighbours across the North Sea.

It has sometimes been hinted that the study of geography has been deliberately discouraged by politicians or by merchants because too much knowledge on the part of the public might embarrass foreign policy or lead to mercantile competition; but we surely cannot entertain such unworthy suspicions. I am inclined to attribute the neglect of the subject merely to ignorance of its nature due to imperfect education.

Two cases in which the application of geography to political and practical affairs suggests a definite course of action may be mentioned as examples. There is still one important colonial boundary entirely undelimited in a region somewhat difficult of access and still little known, where goldfields will probably be found or reported before long, and where a very serious international question may suddenly arise in a part of the world absolutely unsuspected by most people, even amongst those who interest themselves in general politics and in colonial affairs. It would cost a comparative trifle to survey the region in question, and to lay down that boundary line before the goldfields are touched, so that no international trouble could ever arise. What it may cost to postpone the matter until claims have been pegged out on debatable land, the British Guiana and Venezuela arbitration, the Alaska difficulty, and South Africa are there to tell us. It would be interesting to calculate, now that the cost of a week of fighting is known, the saving in pennies on the income tax that would have accrued from a survey of South Africa if that had been carried out as an imperial duty when Cape Colony was settled. I do not for a moment suggest that a survey would have prevented the war; but it is not unreasonable to believe that it would have shortened it by some months. In this connection it is satisfactory to know that a valuable report has been drawn up by a Committee of the British Association, presided over by Sir Thomas Holdich, embodying a scheme for the systematic survey of British protectorates.

The second example comes nearer home. The utilisation of wind- and water-power must increase in importance as mineral fuel diminishes in amount or increases in price. Wind- and water-power will never fail as long as the sun shines and the land remains higher than the sea; but what may fail unless timely precautions are taken is the power of utilising them for the benefit of the community at large. Are the existing laws as to water-rights, and the absence of laws as to the utilisation of wind desirable and satisfactory? The usual answer to such questions is, "Why trouble about that just now? These matters are not urgent, other things are." That argument is answerable for many disasters. The inevitable is in many if not in most cases simply another name for the unforeseen. It is inevitable that the country will be impoverished if the utilisation of wind- and water-power and the transport of that power by electricity are not wisely safeguarded and provided for; but when a survey of our resources, the circulation of the air over our islands, and the effects produced by the interposition of the mountains, plateaus, and valleys upon it, plainly points to the possibility of such a trouble, it only becomes inevitable as a result of culpable negligence.

These two examples, which will not strike anyone whose mind is wholly occupied in paying the penalties of old neglect, illustrate my contention that a complete geographical description based on full investigation is of the highest and most urgent importance, not for this country only, but for the Empire, and for every country in the world.

Nor is it the land alone which claims attention. It is of the utmost importance to investigate and evaluate the resources of the surrounding seas. The recent International Conference for the exploration of the sea held at Christiania formulated a scheme of research which has been taken up enthusiastically by Belgium, Holland, Germany, Denmark, Russia, Sweden and Norway. Its object is to place the fisheries of Northern Europe on a scientific basis, and to make for that purpose a comprehensive survey of the sea, which will prove of high value to meteorology, and through it to agriculture as well. The recent work by Mr. H. N. Dickson on the circulation of the surface waters of the North Atlantic in conjunction with similar work by Prof. Pettersson in Sweden shows how hopeful such researches are from the purely scientific standpoint, and their practical importance is no less. It remains with our Government to show that this country is not indifferent to an opportunity, such as has never presented itself before, of placing one of our great national industries on a basis of scientific knowledge. This is in my belief one of the cases in which the expenditure of thousands now will mean the saving of millions a few years hence.

It is magnificent to send out polar expeditions, and they speak volumes for the greatness of the human mind that can give itself to the advancement of knowledge for the sake of knowledge, knowing that it will bring no material gain; and I trust that such a spirit will continue to manifest itself until no spot of Earth, no land however cold or hot, no depth of sea, no farthest limit of the atmosphere remains unsearched and its lesson unlearnt. But I insist that the full study of our own country is on a totally different footing. Magnificent it may be, too, but sternly practical, since it is absolutely essential for our future well-being, and even for the continuance of the nation as a Power amongst the States of the world. Still, there is every probability that such work will be neglected until the events which it should avert are upon us, and then it will be too late to make provisions which now could be done cheaply, easily, and effectively.

A Proposed Remedy.

The few attempts which have been made in this country to promote the study of geography or to diminish the discouragements to geographical research have had but slight success. Much has been done to improve geographical teaching by the Royal Geographical Society, the Royal Scottish Geographical Society, the Geographical Association, this Section of the British Association, and other bodies; but that is not my theme. I refer to the little that has been done towards the elaboration of a geographical theory and the elucidation of geographical processes. Amongst the not inconsiderable number of teachers of geography in the Universities and Colleges of Great Britain there is not one man who receives a salary on which he can live in decent comfort so as to devote all his time, or a substantial part of it, to geographical research; and the same is true of every official of all the geographical societies. Not one is paid an income sufficient to enable him to devote the time not occupied by mechanical routine to any other purpose than supplementing his income by outside work—writing text-books, correcting examination papers, perhaps even practising journalism. If by an effort and the sacrifice of some of the comforts considered necessary by most people of the professional classes he devotes a few odd hours now and then to some original research, he finds very few to consider it seriously; some friendly expressions of opinion possibly, but scarcely a reader; and it counts for nothing, save, perhaps, in enhancing the reputation of his country in other lands where scientific work, no matter in what department, is valued in a due degree. All this must be changed before much progress can be made. No doubt a giant of genius would ignore all obstacles and pursue his work regardless of recognition; but such giants are not to be looked for many times in a century. It should be made possible for a man of fair abilities to receive as much opportunity, encouragement, recognition and reward for good work in geography as for good work, let us say, in chemistry or electricity. That is all that can reasonably be asked, and that is what is freely accorded in other countries where the status of the man of science is higher than it is with us. It is here that help may be hoped for from the Scottish Universities in the strength of their new endowments. If a Chair of Geography were instituted with the purpose of promoting research first and teaching afterwards, properly equipped with books, maps, and apparatus, and held on the understanding that no outside work was to be undertaken, something might yet be done to restore our country to the position it held a century and a half ago, when a text-book of geography was published without a thought of sarcasm, containing a frontispiece representing "Britannia instructing Europe, Asia, Africa, and America in the Science of Geography."

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY PROF. D. J. CUNNINGHAM, M.D., D.Sc., LL.D., D.C.L., F.R.S., PRESIDENT OF THE SECTION.

TWENTY-FIVE years have passed since the British Association met in Glasgow. This is a long time to look back upon, and yet the period appears short when measured by the great advance which has taken place in almost all branches of knowledge. Anthropology has shared in the general progress. The discoveries made within its confines may not have been so startling, nor yet have had such a direct influence upon the material welfare of the people, as in the case of other fields of scientific study, but its development has been steady and continuous, and it has grown much in public estimation.

At the Glasgow meeting of the Association in 1876 Anthropology held a subsidiary position. It only ranked as a Department, although it gained a special prominence through having Alfred Russel Wallace as its Chairman. It was not until several years later that it became one of the recognised Sections of the Association, and attained the high dignity of having a letter of the alphabet allotted to it. But quite independently of its official status it has always been a branch of study which has been accorded a large amount of popular favour. The anthropological meetings have, as a rule, been well attended, and the discussions, although perhaps on certain occasions somewhat discursive, have never lacked vigour or animation. Prof. Huxley, who presided over the Anthropological Department at the Dublin meeting in 1878, ascribed the popularity of the subject to the many openings which it affords for wide differences of opinion between the exponents of its numerous branches and to the innate bellicose tendency of man. As the representative of a country in which, according to the same high authority, this tendency is less strongly marked than elsewhere, and of a race which has so frequently and pointedly exhibited its abhorrence of vigorous language, I trust that my presence here as President may not react unfavourably on the interest shown in the work of the Section.

The present occasion might appear to be peculiarly appropriate for my taking stock of our anthropological possessions and summing up the numerous additions to our knowledge of "man and his doings" which have been made during the century which has just passed. Such a task, however, is surrounded with so much difficulty that I shrink from undertaking it. The scope of the subject is enormous, and the studies involved so diverse and so varied that I feel that it is beyond my power to give any comprehensive survey of its development in all its parts. I prefer therefore to confine my remarks to that province of Anthropology within which my own work has been chiefly carried on, and from this to select a subject which has for some years held a prominent place in my thoughts. I refer to the human brain and the part which it has played in the evolution of man.

One of the most striking peculiarities of man when regarded from the structural point of view is the relatively great size of his brain. Although with one or two exceptions the several parts of the brain are all more or less involved in this special development, it is the cerebral hemispheres which exhibit the preponderance in the highest degree. This characteristic of the human brain is rendered all the more significant when we consider that the cerebral hemispheres cannot be looked upon as being primitive parts of the brain. In its earliest condition the brain is composed of three simple primary vesicles, and the cerebral hemispheres appear in a secondary manner in the shape of a pair of lateral offshoots or buds which grow out from the foremost of these primitive brain-vesicles.

The offshoots which form the cerebral hemispheres are found in all vertebrates. Insignificant in size and insignificant in functional value in the more lowly forms, a steady increase in their proportions is manifest as we ascend the scale, until the imposing dimensions, the complex structure, and the marvellous functional potentialities of the human cerebral hemispheres are attained. In their development the cerebral hemispheres of man rapidly outstrip all the other parts of the brain until they ultimately usurp to themselves by far the greater part of the cranial cavity. To the predominant growth of the cerebral hemispheres is due the lofty cranial vault of the human skull; to the different degrees of development and to the different forms which they assume are largely due the variations in cranial outline in different individuals and different races—variations in the determination of which the Craniologist has laboured so assiduously and patiently.

I think that it must be manifest to everyone that the work of the Craniologist, if it is to attain its full degree of usefulness, must be founded upon a proper recognition of the relation which exists between the cranium and the brain, or, in other words, between the envelope and its contents.

The cranium expands according to the demands made upon it by the growing brain. The initiative lies with the brain, and in normal conditions it is questionable if the envelope exercises more than a very subsidiary and limited influence upon the form assumed by the contents. The directions of growth are clearly defined by the sutural lines by which the cranial bones are knit together; but these are so arranged that they admit of the expansion of the cranial box in length, in breadth, and in height, and the freedom of growth in each of these different directions has in all probability been originally determined by the requirements of the several parts of the brain.

The base or floor of the cranium, supporting as it does the brain-stem or the parts which possess the greatest phylogenetic antiquity, and which have not undergone so large a degree of modification in human evolution, presents a greater uniformity of type and a greater constancy of form in different individuals and different races than the cranial vault which covers the more highly specialised and more variable cerebral hemispheres.

To what extent and in what directions modifications in the form of the cranium may be the outcome of restrictions placed on the growth of the brain it is difficult to say. But, broadly speaking, I think we may conclude that the influence which the cranium, under normal circumstances, independently exerts in determining the various head-forms is trifling.

When we speak therefore of brachycephalic or short heads, and dolichocephalic or long heads, we are merely using terms to indicate conditions which result from individual or racial peculiarities of cerebral growth.

The brachycephalic brain is not moulded into form by the brachycephalic skull; the shape of both is the result of the same hereditary influence, and in their growth they exhibit the most perfect harmony with each other.

Craniology has been called the "spoiled child of Anthropology." It is supposed that it has absorbed more attention than it deserves, and has been cultivated with more than its share of care, while other fields of Anthropology capable of yielding rich harvests have been allowed to remain fallow. This criticism conveys a very partial truth. The cranium, as we have seen, is the outward expression of the contained brain, and the brain is the most characteristic organ of man; cranial peculiarities therefore must always and should always claim a leading place in the mind of the Anthropologist; and this is all the more imperative seeing that brains of different races are seldom available for investigation, whilst skulls in the different museums may literally be counted by thousands.

Meantime, however, the Craniologist lies buried beneath a mighty mountain of figures, many of which have little morphological value and possess no true importance in distinguishing the finer differences of racial forms. Let us take as an example the figures upon which the cephalic or length-breadth index of the skull is based. The measurement of the long diameter of the cranium does not give the true length of the cranial cavity. It includes, in addition, the diameter of an air-chamber of very variable dimensions which is placed in front. The measurement combines in itself therefore two factors of very different import, and the result is thereby vitiated to a greater or less extent in different skulls. A recent memoir by Schwalbe[1] affords instructive reading on this matter. One case in point may be given. Measured in the usual way, the Neanderthal skull is placed in the dolichocephalic class; whereas Schwalbe has shown that if the brain-case alone be considered it is found to be on the verge of brachycephaly. Huxley, many years ago, remarked that "until it shall become an opprobrium to an ethnological collection to possess a single skull which is not bisected longitudinally" in order that the true proportions of its different parts may be properly determined we shall have no "safe basis for that ethnological craniology which aspires to give the anatomical characters of the crania of the different races of mankind." It appears to me that the truth of this observation can hardly be disputed, and yet this method of investigation has been adopted by very few Craniologists.

It has become too much the habit to measure and compare crania as if they were separate and distinct entities, and without a due consideration of the evolutionary changes through which both the brain and its bony envelope have passed. Up to the present little or no effort has been made to contrast those parts of the cranial wall or cavity which have been specially modified by the cerebral growth-changes which are peculiar to man. It may be assumed that these changes have not taken place to an equal extent, or indeed followed identically the same lines in all races.

Unfortunately our present knowledge of cerebral growth and the value to be attached to its various manifestations is not so complete as to enable us to follow out to the full extent investigations planned on these lines. But the areas of cerebral cortex to which man owes his intellectual superiority are now roughly mapped out, and the time has come when the effect produced upon the cranial form by the marked extension of these areas in the human brain should be noted and the skulls of different races contrasted from this point of view.

To some this may seem a return to the old doctrine of Phrenology, and to a certain extent it is; but it would be a Phrenology based upon an entirely new foundation and elaborated out of entirely new material.

It is to certain of the growth-changes in the cerebrum which I believe to be specially characteristic of man, and which un-

1 "Studien über Pithecanthropus erectus" (Dubois). *Zeitschrift f. Morph. und Anthrop.*, Band i. Heft 1, 1899.

questionably have had some influence in determining head-forms, that I wish particularly to refer in this Address.

The surface of the human cerebrum is thrown into a series of tortuous folds or convolutions separated by slits or fissures, and both combine to give it an appearance of great complexity. These convolutions were long considered to present no definite arrangement, but to be thrown together in the same meaningless disorder as is exhibited in a dish of macaroni. During the latter half, or rather more, of the century which has just ended it has, however, been shown by the many eminent men who have given their attention to this subject that the pattern which is assumed by the convolutions, while showing many subsidiary differences, not only in different races and different individuals, but also in the two hemispheres of the same person, is yet arranged on a consistent and uniform plan in every human brain, and that any decided deviation from this plan results in an imperfect carrying out of the cerebral function. In unravelling the intricacies of the human convolutionary pattern it was very early found that the simple cerebral surface of the ape's brain in many cases afforded the key to the solution of the problem. More recently the close study of the manner in which the convolutions assume shape during their growth and development has yielded evidence of a still more valuable kind. We now know that the primate cerebrum is not only distinguished from that of all lower mammals by the possession of a distinct occipital lobe, but also by having imprinted on its surface a convolutionary design, which in all but a few fundamental details is different from that of any other order of mammals.

There are few matters of more interest to those anthropologists who make a study of the human skull than the relationship which exists between the cranium and the brain during the period of active growth of both. Up to the time immediately prior to the pushing out of the occipital lobe, or, in other words, the period in cerebral development which is marked by the transition from the quadrupedal type to the primate type of cerebrum, the cranial wall fits like a tight glove on the surface of the enclosed cerebrum. At this stage there would appear to be a growth antagonism between the brain and the cranial envelope which surrounds it. The cranium, it would seem, refuses to expand with a speed sufficient to meet the demands made upon it for the accommodation of the growing brain. In making this statement it is right to add that Hochstetter, in a carefully reasoned memoir, has recently cast doubt upon the reality of the appearances which have led to this conclusion, and at the recent meeting of the Anatomische Gesellschaft, in Bonn, Prof. Gustaf Retzius,[1] one of the numerous observers responsible for the description of the early cerebrum upon which the conclusion is based, showed some inclination to waver in his allegiance to the old doctrine. This is not the time or the place to enter upon a discussion of so technical a kind, but I may be allowed to say that whilst I fully recognise the necessity for further and more extensive investigation into this matter I do not think that Hochstetter has satisfactorily accounted for all the circumstances of the case.

When the occipital lobe assumes shape the relationship of the cranial wall to the enclosed cerebrum undergoes a complete change. The cranium expands so rapidly that very soon a wide interval is left between the surface of the cerebrum and the deep aspect of the cranial envelope within which it lies. This space is occupied by a soft, sodden, spongy meshwork, termed the subarachnoid tissue, and it is into the yielding and pliable bed thus prepared that the convolutions grow. At first the surface of the cerebral hemisphere is smooth, but soon particular areas of the cortex begin to bulge out and foreshadow the future convolutions. These suffer no growth restriction, and they assume the form of round or elongated elevations or eminences which rise above the general surface level of the cerebral hemisphere and break up its uniform contour lines in the same manner that mountain chains protrude from the surface of the globe.

As growth goes on, and as the brain gradually assumes a bulk more nearly in accord with the cavity of the cranium, the space for surface protrusions of this kind becomes more limited. The gyral elevations are now pressed together: they become flattened along their summits, and in course of time they acquire the ordinary convolutionary shapes. While this is going on the valleys or intervals between the primitive surface elevations become narrowed, and ultimately assume the linear slit-like form characteristic of the fissures. These changes occur shortly before birth, but are not fully completed until after the first few months of infancy. The final result of this process is that the convolutions come into intimate relation with the deep aspect of the cranial wall and stamp their imprint upon it.

It is obvious that certain of the later changes which I have endeavoured to portray might be ascribed to a growth antagonism between the brain and the enclosing cranium at this period. In reality, however, it is merely a process by which the one is brought into closer adaptation to the other—a using up, as it were, of superfluous space and a closer packing together of the convolutions—after the period of active cortical growth is past. Nevertheless the convolutionary pattern is profoundly affected by it, and it seems likely that in this process we find the explanation of the different directions taken by the cerebral furrows in brachycephalic and dolichocephalic heads.

The cortical elevations which rise on the surface of the early cerebrum are due to exuberant growth in localised areas. There cannot be a doubt that the process is intimately connected with the development of function in the districts concerned. We know that functions of different kinds are localised in different parts of the cortex, and when we see an area on the surface of the early cerebrum rise up in the form of an eminence we may reasonably conclude that the growth in the area concerned is the structural foundation of what will become later on a centre of functional activity of an acute kind.

A consideration of this matter gives the clue to the simple convolutions of the ape and the complex convolutions of man, and, further, it explains how the interrupted form of fissural development is one of the essential characteristics of the human brain as compared with the simian brain. Areas which rise up in the form of one long elevation on the surface of the ape's brain appear in the form of several eminences on the surface of the human brain, and fissures which appear in the form of long continuous slits in the simian cerebrum appear in the human cerebrum in several detached bits, which may or may not in the course of time run into each other and become confluent. All this is due to the greater definition, refinement, and perfection of the functions carried on in the cerebral cortex of man. It is an index of a more complete "physiological division of labour" in the human brain.

It is not necessary, for the purpose I have in view, to enter into any detail regarding the many points of difference which become evident when the cerebral surface of the ape is compared with that of man. It is more my purpose to indicate certain of the districts of cerebral cortex which have undergone a marked increase in the human brain—an increase which may be reasonably supposed to be associated with the high mental attributes of man. To us, at the present time, it is difficult to conceive how it was ever possible to doubt that the occipital lobe is a distinctive character of the simian brain as well as of the human brain, and yet at successive meetings of this Association (1860, 1861, and 1862) a discussion, which was probably one of the most heated in the whole course of its history, took place on this very point. One of our greatest authorities on animal structure maintained that the occipital lobe and the hippocampus minor—an elevation in its interior—were both peculiar to man and to him alone. Everyone has read in the "Water Babies" Charles Kingsley's delightful account of this discussion. Speaking of the Professor he says: "He held very strange theories about a good many things. He had even got up at the British Association and declared that apes had hippopotamus majors in their brains just as men have. What a shocking thing to say; for if it were so, what would become of the faith, hope and charity of immortal millions? You may think that there are other more important differences between you and an ape, such as being able to speak, and make machines, and know right from wrong, and say your prayers, and other little matters of that kind; but that is a child's fancy." In the light of our present knowledge we can fully understand Prof. Huxley closing the discussion by stating that the question had "become one of personal veracity." Indeed, the occipital lobe, so far from being absent, is developed in the ape to a relatively greater extent than in man, and this constitutes one of the leading positive distinctive characters of the simian cerebrum. Measured along the mesial border, the percentage length of the occipital lobe to the total length of the cerebrum in the baboon, orang, and man is as follows:—

Baboon	29·7
Orang	23·2
Man	21·2

[1] Anatomische Gesellschaft. Bonn, May 21, 1901. Gustaf Retzius, "Transitorische Furchen des Grosshirns."

But these figures do not convey the full extent of the predominance of the occipital lobe in the ape. The anterior border of the lobe grows forwards beyond its proper limits, and pushes its way over the parietal lobe which lies in front, so as to cover over a portion of it by an overlapping lip termed the occipital operculum. There is not a trace of such an arrangement in the human brain, and even in the anthropoid ape the operculum has become greatly reduced. Indeed, in man there is exactly the reverse condition. The great size of the parietal lobe is a leading human character, and it has partly gained its predominance by pushing backwards so as to encroach, to some extent, upon the territory which formerly belonged to the occipital lobe.[1] A great authority[2] on the cerebral surface refers to this as a struggle between the two lobes for surface extension of their respective domains. "In the lower apes," he says, "the occipital lobe proves the victor: it bulges over the parietal lobe as far as the first annectant gyrus. Already, in the orang, the occipital operculum has suffered a great reduction; and in man the victory is on the side of the parietal lobe which presses on the occipital lobe and begins, on its part, to overlap it." Now that so much information is available in regard to the localisation of function in the cerebral cortex, and Flechsig has stimulated our curiosity in regard to his great "association areas" in which the higher intellectual powers of man are believed to reside, it is interesting to speculate upon the causes which have led to the pushing back of the scientific frontier between the occipital and parietal cerebral districts.

The parietal lobe is divided into an upper and a lower part by a fissure, which takes an oblique course across it. Rudinger,[3] who studied the position and inclination of this fissure, came to the conclusion that it presents easily determined differences in accordance with sex, race and the intellectual capacity of the individual. He had the opportunity of studying the brains of quite a number of distinguished men, amongst whom were Bischoff of Bonn, Döllinger of Munich, Tiedemann of Heidelberg, and Liebig of Munich, and he asserts that the higher the mental endowment of an individual the greater is the relative extent of the upper part of the parietal lobe.

There is absolutely no foundation for this sweeping assertion. When the evolutionary development of the parietal part of the cerebral cortex is studied exactly the reverse condition becomes manifest. It is the lower part of the parietal lobe which in man, both in its early development and in its after growth, exhibits the greatest relative increase. Additional interest is attached to this observation by the fact that recently several independent observers have fixed upon this region as one in which they believe that a marked exuberance of cortical growth may be noted in people of undoubted genius. Thus Retzius has stated that such was the case in the brains of the astronomer Hugo Gyldén,[4] and the mathematician Sophie Kovalevsky;[5] Hansemann[6] has described a similar condition in the brain of Helmholtz; and Guszman[7] in the brain of Rudolph Lenz, the musician. Some force is likewise added to this view by Flechsig, who, in a recent paper,[8] has called attention to the fact that within this district there are located two of his so-called "Terminalgebiete," or cortical areas, which attain their functional powers at a later period than those which lie around them, and which may therefore be supposed to have specially high work to perform.

Without in any way desiring to throw doubt upon the observations of these authorities, I think that at the present moment it would be rash to accept, without further evidence, conclusions which have been drawn from the examination of the few brains of eminent men that have been described. There cannot be a doubt that the region in question is one which has extended greatly in the human brain, but the association of high intellect with a special development of the region is a matter on which I must confess I am at present somewhat sceptical.

But it is not only in a backward direction that the parietal lobe in man has extended its territory. It has likewise increased in a downward direction. There are few points more striking than this in the evolution of the cerebral cortex of man. In order that I may be able to make clear the manner in which this increase has been brought about, it will be necessary for me to enter into some detail in connection with the development of a region of cerebral surface termed the *insular district*. The back part of the frontal lobe is also involved in this downward extension of surface area, and, such being the case, it may be as well to state that the boundary which has been fixed upon as giving the line of separation between the parietal and frontal districts is purely artificial and arbitrary. It is a demarcation which has no morphological significance, whilst from a physiological point of view it is distinctly misleading.

The insular district in the fœtal brain is a depressed area of an elongated triangular form. The general surface of the cerebrum occupies, all round about it, a more elevated plane, and thus the insula comes to be bounded by distinct walls, like the sides of a shallow pit dug out in the ground. The upper wall is formed by the lower margins of the frontal and parietal lobes, the lower wall by the upper margin of the temporal lobe, and the front wall by the frontal lobe. From each of these bounding walls a separate portion of cerebral cortex grows, and these gradually creep over the surface of the insula so as to overlap it, and eventually completely cover it over and exclude it from the surface, in the same way that the lips overlap the teeth and gums. That which grows from above is called the *fronto-parietal operculum*, while that which grows from below is termed the *temporal operculum*. These appear very early, and are responsible for closing over more than the hinder three-fourths of the insula. The lower or temporal operculum is in the first instance more rapid in its growth than the upper or fronto-parietal operculum, and thus it comes about that when their margins meet more of the insula is covered by the former than by the latter. So far the development is apparently precisely similar to what occurs in the ape. The slit or fissure formed by the approximation of the margins of these two opercula is called the Sylvian fissure, and it constitutes a natural lower boundary for the parietal and frontal lobes which lie above it. At first, from the more energetic growth of the lower temporal operculum, this fissure slants very obliquely upwards and backwards, and is very similar in direction to the corresponding fissure in the brain of the ape. But in the human brain this condition is only temporary. Now begins that downward movement of the parietal lobe and back part of the frontal lobe to which reference has been made. The upper or fronto-parietal operculum, in the later stages of fœtal life and the earlier months of infancy, enters into a growth antagonism with the lower or temporal operculum, and in this it proves the victor. The margins of the two opercula are tightly pressed together, and, slowly but surely, the fronto-parietal operculum gains ground, pressing down the temporal operculum, and thus extending the territory of the frontal and parietal districts. This is a striking process in the brain development of man, and it results in a depression of the Sylvian fissure or the lower frontier line of the frontal and parietal lobes. Further, to judge from the oblique direction of the Sylvian fissure in the brain of the ape, the process is peculiar to man; in the simian brain there is no corresponding increase in the area of cerebral cortex under consideration.

I do not think that it is difficult to account for this important expansion of the cerebral surface. In the fore part of the region involved are placed the groups of motor centres which control the muscular movements of the more important parts of the body. These occupy a broad strip of the surface which stretches across the whole depth of the district concerned. Within this are the centres for the arm and hand, for the face, the mouth and the throat, and likewise, to some extent, the centre for speech. In man certain of these have undoubtedly undergone marked expansion. The skilled movements of the hands, as shown in the use of tools, in writing, and so on, have not been acquired without an increase in the brain mechanism by which these are guided. So important, indeed, is the part played by the human hand as an agent of the mind, and so perfectly is it adjusted with reference to this office, that there are many who think that the first great start which man obtained on the path

[1] It is necessary to emphasise this point, because in Wiedersheim's "Structure of Man" we are told that in man there is a preponderance of the occipital lobe, and that the parietal lobe is equally developed in man and anthropoids.

[2] Eberstaller, *Wiener Medizinische Blatter*, 1884, No. 19, p. 581.

[3] "Beiträge zur Anatomie und Embryologie," als Festgabe, Jacob Henle, 1882.

[4] Retzius, *Biologische Untersuchungen*, neue Folge, viii. 1898, "Das Gehirn des Astronomen Hugo Gyldéns.

[5] Retzius, *Biologische Untersuchungen*, neue Folge, ix. 1900, "Das Gehirn der Mathematikerin Sonja Kovalevsky."

[6] Hansemann, *Zeitschrift fur Psychologie und Physiologie der Sinnesorgane*, Band xx. Heft 1, 1899, "Ueber das Gehirn von Hermann v. Helmholtz."

[7] Josef Guszman, *Anatomischer Anzeiger*, Band xix. Nos. 9 and 10, April 1901, "Beiträge zur Morphologie der Gehirnoberfläche."

[8] Flechsig, "Neue Untersuchungen über die Markbildung in den menschlichen Grosshirnlappen," *Neurologisches Centralblatt*, No. 21, 1898.

which has led to his higher development was given by the setting of the upper limb free from the duty of acting as an organ of support and locomotion. It is an old saying "that man is the wisest of animals because of his hands." Without endorsing to its full extent this view, I think that it cannot be a matter for surprise that the district of the cerebral cortex in man in which the arm-centres reside shows a manifest increase in its extent.

In the same region of cerebral cortex, but at a lower level, there are also situated the centres which are responsible for facial expression. In the ape there is a considerable degree of facial play; but this is chiefly confined to the region of the lips; and the muscles of the face, although present in greater mass, show comparatively little of the differentiation which is characteristic of the lighter and more feeble muscles in the face of man. And then as to the effect produced: These human muscles are capable of reflecting every fleeting emotion, every change of mind, and by the lines and furrows their constant use indelibly fix on the countenance the character and disposition of an individual can to some extent be read. As the power of communication between primitive men became gradually established, facial movements were no doubt largely used, not only for the purpose of giving expression to simple emotions, such as anger or joy, but also for giving point and force to the faltering speech of our early progenitors by reflecting other conditions of mind. The acquisition of this power as well as the higher and more varied powers of vocalisation must necessarily have been accompanied by an increase of cerebral cortex in the region under consideration. And in this connection it is a point well worthy of note that the area of cortex mapped out in the human brain[1] as controlling the muscles of the face, mouth, and throat is as large, if not larger than that allotted to the arm and hand,[2] and yet it is questionable if all the muscles under the sway of the former would weigh as much as one of the larger muscles (say the triceps) of the arm. This is sufficient to show that it is not muscle power which determines the extent of the motor areas in the cerebral cortex. It is the degree of refinement in the movements required, as well as the degree of variety in muscle combinations, which apparently determines the amount of ground covered by a motor centre.

Still, the increase in the amount of cerebral cortex in man due to the greater refinement of movement acquired by different groups of muscles is relatively small in comparison with the increase which has occurred in other regions from which no motor fibres are sent out, and which therefore have no direct connection with muscles.

The remarkable conclusions arrived at by Flechsig, although not confirmed and accepted in all their details, have tended greatly to clear up much that was obscure in the relations of the different districts of cerebral cortex. More particularly has he been able to apportion out more accurately the different values to be attached to the several areas of the cerebral surface. He has shown that fully two thirds of the cortex in the human brain constitute what he terms "association centres." Within these the higher intellectual manifestations of the brain have their origin, and judgment and memory have their seat. They are therefore to be regarded as the psychic centres of the cerebral cortex.

Now, it requires a very slight acquaintance with the cerebral surface to perceive that the great and leading peculiarity of the human brain is the wide extent of these higher association centres of Flechsig. Except in connection with new faculties, such as speech, there has been relatively no striking increase in the extent of the motor areas in man as compared with the cortex of the ape or the idiot, but the expansion of the association areas is enormous and the increase in the frontal region and the back part of the parietal region is particularly well marked. It is this parietal extension of surface which is chiefly responsible for the pushing down of the lower frontier of the parietal lobe and the consequent enlargement of its territory.

I have already referred to the views which have been recently urged by several independent observers, that in the men who have been distinguished during life by the possession of exceptional intellectual power, this region has shown a very special development.

It is a curious circumstance, and one which is worthy of consideration, that in the left cerebral hemisphere the Sylvian fissure or the lower boundary of the parietal lobe is more depressed than in the right hemisphere, and, as a result of this, the surface area occupied by the parietal lobe is greater on the left side of the brain than on the right side. To the physiologist it is a matter of every-day knowledge that the left cerebral hemisphere shows in certain directions a marked functional preeminence. Through it the movements of the right arm and right side of the body are controlled and regulated. Within it is situated also the active speech centre. This does not imply that there is no speech centre on the right side, but simply that the left cerebral hemisphere has usurped the chief, if not the entire, control of this all-important function, and that from it are sent out the chief part, if not the whole, of the motor incitations which give rise to speech. The significance attached to the dominant power of the left hemisphere receives force from the now well-established fact that in left-handed individuals the speech function is also transferred over to the right side of the brain. To account for this functional preeminence of the left cerebral hemisphere numerous theories have been elaborated. The interest attached to the subject is very considerable, but it is impossible on the present occasion to do more than indicate in the briefest manner the three views which have apparently had the widest influence in shaping opinion on this question. They are: (1) that the superiority of the left cerebral hemisphere is due to its greater weight and bulk; (2) that it may be accounted for by the greater complexity of the convolutions on the left brain and the fact that these make their appearance earlier on the left side than on the right side; (3) that the explanation lies in the fact that the left side of the brain enjoys greater advantages in regard to its blood supply than the right side.

Not one of these theories when closely looked into is found to possess the smallest degree of value. Braune[1] has shown in the most conclusive manner that if there is any difference in weight between the two hemispheres it is a difference in favour of the right and not of the left hemisphere; and I may add from my own observations that this is evident at all periods of growth and development. Equally untrustworthy are the views that have been put forward as to the superiority of the left hemisphere from the point of view of convolutionary development. I am aware that it is stated that in two or three cases where the brains of left-handed people have been examined this superiority was evident on the right hemisphere. This may have been so; I can only speak for the large percentage of those who are right-handed; and I have never been able to satisfy myself that either in the growing or fully developed brain is there any constant or marked superiority in this respect of the one side over the other; and I can corroborate Ecker (*Archiv für Anthropologie*, 1868, Bd. cxi.) in his statement that there is no proof that the convolutions appear earlier on the one side than the other. The theory that an explanation is to be found in a more generous blood supply to the left hemisphere is more difficult to combat, because the amount of blood received by each side of the brain depends upon two factors, viz., the physical conditions under which the blood-stream is delivered to the two hemispheres and the calibre of the arteries or tubes of supply. Both of these conditions have been stated to be favourable to the left hemisphere. It is a matter of common anatomical knowledge that the supply pipes to the two sides of the brain are laid down somewhat differently, and that the angles of junction, &c., with the main pipe are not quite the same. Further, it is true that the blood-drains which lead away the blood from the brain are somewhat different on the two sides. Whether this would entail any marked difference in the blood-pressure on the two sides I am not prepared to say. This could only be proved experimentally; but, taking all the conditions into consideration, I am not inclined to attach much importance to the argument It is easy to deal with the loose statements which have been made in regard to the size of leading supply pipe (viz., the internal carotid artery). It passes through a bony canal in the floor of the cranium on its way into the interior of the cranial box. Its size can therefore be accurately gauged by measuring the sectional area of this bony tunnel on each side.

1 See diagram in Schäfer's article on the "Cerebral Cortex" in his recent work on physiology.

2 The comparison only refers to surface area, and this is not an absolutely true criterion of the relative amount of cortex in each region. The arm-centre has a large amount of cortex stowed away within the fissure of Rolando in the shape of inter-locking gyri which is not taken into account in a measurement confined to the superficial surface area. Still, this does not to any great degree detract from the argument which follows, seeing that the discrepancy is still sufficiently marked.

1 "Das Gewichtsverhältniss der rechten zur linken Hirnhälfte beim Menschen" (*Archiv für Anat.*).

This I have done in twenty-three skulls chosen at random, and the result shows that considerable differences in this respect are to be found in different skulls. These discrepancies, however, are sometimes in favour of the one side and at other times in favour of the other side; and when the combined sectional area for all the skulls examined was calculated it was, curiously enough, found to be 583⅓ sq. mm. for the left side and 583 sq. mm. for the right side.

Leaving out of count the asymmetry in the arrangement of the convolutions in the two hemispheres, which cannot by any amount of ingenuity be twisted into such a form as to give a structural superiority to one side more than the other, the only marked difference which appears to possess any degree of constancy is the increase in the territory of the left parietal lobe produced by the more marked depression of its lower frontier line (Sylvian fissure). That this is in any way associated with right-handedness or with the localisation of the active speech centre in the left hemisphere I am not prepared to urge, because the same condition is present in the ape. It is true that some authorities[1] hold that the ape is right-handed as well as man, but in the gardens of the Royal Zoological Society of Ireland I have had a long and intimate experience of both anthropoid and lower apes, and I have never been able to satisfy myself that they show any decided preference for the use of one arm more than the other.

That differences do exist in the more intimate structural details of the two hemispheres, which give to the left its functional superiority, there cannot be a doubt; but these have still to be discovered. Bastian has stated that the grey cortex on the left side has a higher specific gravity, but this statement has not as yet received corroboration at the hands of other observers.

I have already mentioned that man's special endowment, the faculty of speech, is associated with striking changes in that part of the celebral surface in which the motor centre for articulate speech is located. It is questionable whether the acquisition of any other system of associated muscular movements has been accompanied by a more evident cortical change. The centre in question is placed in the lower and back part of the frontal lobe. We have seen that the insular district is covered over in the hinder three-fourths of its extent by the fronto-parietal and temporal opercula, and thus submerged below the surface and hidden from view. The brain of the ape and also of the microcephalic idiot with defective speech goes no further in its development. The front part of the insular district remains uncovered and exposed to view on the surface of the cerebrum. In man, however, two additional opercula grow out and ultimately cover over the fore part of the insula. These opercula belong to the lower and back part of the frontal lobe, and are to be looked upon as being more or less directly called into evidence in connection with the acquisition of articulate speech.

The active speech centre is placed in the left cerebral hemisphere. We speak from the left side of the brain, and yet when the corresponding region[2] on the right side is examined it is found to go through the same developmental steps.

The stimulus which must have been given to general cerebral growth in the association areas by the gradual acquisition of speech can hardly be exaggerated.

During the whole course of his evolution there is no possession which man has contrived to acquire which has exercised a stronger influence on his higher development than the power of articulate speech. This priceless gift, "the most human manifestation of humanity"—(Huxley)—was not obtained through the exertions of any one individual or group of individuals. It is the result of a slow process of natural growth, and there is no race, no matter how low, savage or uncultured, which does not possess the power of communicating its ideas by means of speech. "If in the present state of the world," says Charma, "some philosopher were to wonder how man ever began to build those houses, palaces and vessels which we see around us, we should answer that these were not the things that man began with. The savage who first tied the branches of shrubs to make himself a shelter was not an architect, and he who first floated on the trunk of a tree was not the creator of navigation." And so it is with speech. Rude and imperfect in its beginnings, it has gradually been elaborated by the successive generations that have practised it.

The manner in which the faculty of speech originally assumed shape in the early progenitors of man has been much discussed by Philologists and Psychologists, and there is little agreement on the subject. It is obvious that all the more intelligent animals share with man the power of giving expression to certain of the simpler conditions of mind both by vocal sounds and by bodily gestures. These vocal sounds are of the interjectional order, and are expressive of emotions or sensations. Thus the dog is said, as a result of its domestication, to have acquired the power of emitting four or five different tones, each indicative of a special mental condition and each fully understood by its companions. The common barn-door fowl has also been credited with from nine to twelve distinct vocal sounds, each of which is capable of a special interpretation by its fellows or its chickens. The gestures employed by the lower animals may in certain cases be facial, as expressed by the grimaces of a monkey, or changes in bodily attitude, as we see continually in the dog.

I think that it may not be unreasonably inferred that in the distant past the remote progenitors of man relied upon equally lowly means of communicating with their fellows, and that it was from such humble beginnings that speech has been slowly evolved.

There cannot be a doubt that this method of communicating by vocal sounds, facial expression and bodily gestures is capable of much elaboration; and, further, it is possible, as some hold, that it may have attained a considerable degree of perfection before articulate speech began to take form and gradually replace it. Much of it indeed remains with us to the present day. A shrug of the shoulders may be more eloquent than the most carefully prepared phrase; an appropriate expression of face, accompanied by a suitable ejaculation, may be more withering than a flood of invective. Captain Burton tells us of a tribe of North American Indians whose vocabulary is so scanty that they can hardly carry on a conversation in the dark. This and other facts have led Mr. Tylor, to whom we owe so much in connection with the early history of man, to remark: "The array of evidence in favour of the existence of tribes whose language is incomplete without the help of gesture-signs, even for things of ordinary import, is very remarkable"; and, further, "that this constitutes a telling argument in favour of the theory that gesture-language is the original utterance of mankind out of which speech has developed itself more or less fully among different tribes." It is a significant fact also, as the same author points out, that gesture-language is, to a large extent, the same all the world over.

Many of the words employed in early speech were undoubtedly formed, in the first instance, through the tendency of man to imitate the natural sounds he heard around him. To these sounds, with various modifications, was assigned a special conventional value, and they were then added to the growing vocabulary. By this means a very decided forward step was taken, and now primitive man became capable of giving utterance to his perceptions by imitative sounds.

Max Müller, although bitterly opposed to the line of thought adopted by the "Imitative School" of philologists, has expressed their views so well that I am tempted to use the words he employed in explaining what he satirically branded as the "Bow-wow Theory." He says: "It is supposed that man, being yet mute, heard the voices of the birds, dogs, and cows, the roaring of the sea, the rustling of the forest, the murmur of the brook, and the whisper of the breeze. He tried to imitate these sounds, and finding his mimicking cries useful as signs of the object from which they proceeded, he followed up the idea and elaborated language."

Hood[1] humorously and unconsciously illustrates this doctrine by a verse descriptive of an Englishman, ignorant of French, endeavouring to obtain a meal in France:—

"'Moo!' I cried for milk;
If I wanted bread
My jaws I set agoing;
And asked for new-laid eggs
By clapping hands and crowing."

[1] Ogle, "On Dextral Preeminence," *Trans.* Med. Chirurg. Soc., 1871; Aimé Père, "Les Courbures latérales normales au rachis humain." (Toulouse, 1900.)

[2] Rudinger and others have tried on very unsubstantial grounds to prove that there is a difference in this region on the two sides of the brain. There is, of course, as a rule, marked asymmetry; but I do not think that it can be said with truth that the cortical development of the region is greater on the left side than on the right.

[1] Quoted from "The Origin of Language," by Hensleigh Wedgwood, 1866.

But, although much of early articulate speech may have arisen by the development of interjectional sounds and the reproduction, by the human vocal organs, of natural sounds, it is very unlikely that these afforded the only sources from which words were originally derived. Romanes insists upon this, and, in support of his argument, refers to cases where children invent a language in which apparently imitative sounds take no part. He likewise alludes to the well-known fact that deaf mutes occasionally devise definite sounds which stand for the names of friends. In the light of such evidence, he very properly asks, "Why should it be held impossible for primitive man to have done the same?"

The value of spoken language, as an instrument of thought, is universally admitted, and it is a matter incapable of contradiction that the higher intellectual efforts of man would be absolutely impossible were it not for the support which is afforded by articulate speech. Darwin expresses this well when he says: "A complex train of thought can no more be carried on without the aid of words, whether spoken or silent, than a long calculation without the use of figures or symbols." Such being the case, I think we may conclude that the acquisition of speech has been a dominant factor in determining the high development of the human brain. Speech and mental activity go hand in hand. The one has reacted on the other. The mental effort required for the coining of a new word has been immediately followed by an increased possibility of further intellectual achievement through the additional range given to the mental powers by the enlarged vocabulary. The two processes, mutually supporting each other and leading to progress in the two directions, have unquestionably yielded the chief stimulus to brain development.

More than one Philologist has insisted that "language begins where interjection ends." For my part I would say that the first word uttered expressive of an external object marked a new era in the history of our early progenitors. At this point the simian or brute-like stage in their developmental career came to an end and the human dynasty endowed with all its intellectual possibilities began. This is no new thought. Romanes clearly states that in the absence of articulation he considers it improbable that man would have made much psychological advance upon the anthropoid ape, and in another place he remarks that "a man-like creature became human by the power of speech."

The period in the evolution of man at which this important step was taken is a vexed question and one in the solution of which we have little solid ground to go upon beyond the material changes produced in the brain and the consideration of the time that these might reasonably be supposed to take in their development.

Darwin was inclined to believe that articulate speech came at an early period in the history of the stem-form of man. Romanes gives a realistic picture of an individual decidedly superior to the anthropoid ape, but distinctly below the existing savages. This hypothetical form, half-simian, half-human, was, according to his sponsor, probably erect; he had arrived at the power of shaping flints as tools, and was a great adept at communicating with his fellows by gesture, vocal tones, and facial grimaces.

With this accomplished ancestor in his mental eye it is not surprising that Romanes was inclined to consider that articulate speech may have come at a later period than is generally supposed.

At the time that Romanes gave expression to these views he was not acquainted with the very marked structural peculiarities which distinguish the human brain in the region of the speech centre. I do not refer to the development of the brain in other districts, because possibly Romanes might have held that the numerous accomplishments of his speechless ancestor might be sufficient to account for this; I merely allude to changes which may reasonably be held to have taken place in direct connection with the gradual acquisition of speech.

These structural characters constitute one of the leading peculiarities of the human cerebral cortex, and are totally absent in the brain of the anthropoid ape and of the speechless microcephalic idiot.

Further, it is significant that in certain anthropoid brains a slight advance in the same direction may occasionally be faintly traced, whilst in certain human brains a distinct backward step is sometimes noticeable. The path which has led to this special development is thus in some measure delineated.

It is certain that these structural additions to the human brain are no recent acquisition by the stem-form of man, but are the result of a slow evolutionary growth—a growth which has been stimulated by the laborious efforts of countless generations to arrive at the perfect coordination of all the muscular factors which are called into play in the production of articulate speech.

Assuming that the acquisition of speech has afforded the chief stimulus to the general development of the brain, and thereby giving it a rank high above any other factor which has operated in the evolution of man, it would be wrong to lose sight of the fact that the first step in this upward movement must have been taken by the brain itself. Some cerebral variation—probably trifling and insignificant at the start, and yet pregnant with the most far-reaching possibilities—has in the stem-form of man contributed that condition which has rendered speech possible. This variation, strengthened and fostered by natural selection, has in the end led to the great double result of a large brain with wide and extensive association areas and articulate speech, the two results being brought about by the mutual reaction of the one process upon the other.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY PROF. JOHN G. MCKENDRICK, M.D., LL.D., F.R.S., PRESIDENT OF THE SECTION.

WHEN the British Association met in Glasgow twenty-five years ago I had the honour of presiding over Physiology, which was then only a sub-section of Section D. The progress of the science during the quarter of a century has been such as to entitle it to the dignity of a Section of its own, and I feel it to be a great honour to be again put in charge of the subject. While twenty-five years form a considerable portion of the life of a man, from some points of view they constitute only a short period in the life of a science. But just as the growth of an organism does not always proceed at the same rate, so is it with the growth of a science. There are times when the application of new methods or the promulgation of a new theory causes rapid development, and there are other times when progress seems to be slow. But even in these quiet periods there may be steady progress in the accumulation of facts, and in the critical survey of old questions from newer points of view. So far as physiology is concerned, the last quarter of a century has been singularly fruitful, not merely in the gathering in of accurate data by scientific methods of research, but in the way of getting a deeper insight into many of the problems of life. Thus our knowledge of the phenomena of muscular contraction, of the changes in the secreting cell, of the interdependence of organs illustrated by what we now speak of as internal secretion, of the events that occur in the fecundated ovum and in the actively growing cell, of the remarkable processes connected with the activity of an electrical organ, and of the physiological anatomy of the central nervous organs, is very different from what it was twenty-five years ago. Our knowledge is now more accurate, it goes deeper into the subject, and it has more of the character of scientific truth. For a long period the generalisations of physiology were so vague, and apparently so much of the nature of more or less happy guesses, that our brethren the physicists and chemists scarcely admitted the subject into the circle of the sciences. Even now we are sometimes reproached with our inability to give a complete solution of physiological problem, such as, for example, what happens in a muscle when it contracts; and not long ago physiologists were taunted by the remark that the average duration of a physiological theory was about three years. But this view of the matter can only be entertained by those who know very little about the science. They do not form a just conception of the difficulties that surround all physiological investigation, difficulties far transcending those relating to research in dead matter; nor do they recollect that many of the more common phenomena of dead matter are still inadequately explained. What, for example, is the real nature of elasticity; what occurs in dissolving a little sugar or common salt in water; what is electrical conductivity? In no domain of science, except in mathematics, is our knowledge absolute; and physiology shares with the other sciences the possession of problems that, if I may use a paradox, seem to be more insoluble the nearer we approach their solution.

The body of one of the higher animals—say that of man—is a highly complex mechanism, consisting of systems of organs, of individual organs, and of tissues. Physiologists have been able to give an explanation of the more obvious phenomena. Thus locomotion, the circulation of the blood, respiration, digestion, the mechanism of the senses, and the general phenomena of the nervous system have all been investigated, and in a general way they are understood. The same statement may be made as to the majority of individual organs. It is when we come to the phenomena in the living tissues that we find ourselves in difficulties. The changes happening in any living cell, let it be a connective tissue corpuscle, or a secreting cell, or a nerve-cell, are still imperfectly understood; and yet it is upon these changes that the phenomena of life depend. This has led the more thoughtful physiologists in recent years back again to the study of the cell and of the simple tissues that are formed from cells. Further, it is now recognised that if we are to give an adequate explanation of the phenomena of life, we should study these, not in the body of one of the lower organisms, as was at one time the fashion, where there is little if any differentiation of function—the whole body of an amœboid organism showing capacities for locomotion, respiration, digestion, &c.—but in the specialised tissue of one of the higher animals. Thus the muscle-cell is specialised for contraction, and varieties of epithelium have highly specialised functions.

But when cells are examined with the highest microscopic powers, and with the aid of the highly elaborated methods of modern histology, we do not seem to have advanced very far towards an explanation of the ultimate phenomena. There is the same feeling in the mind of the physiologist when he attacks the cell from the chemical side. By using large numbers of cellular elements, or by the more modern and fruitful methods of micro-chemistry, he resolves the cell-substance into proteids, carbohydrates, fats, saline matter and water, with possibly other substances derived from the chemical changes happening in the cell while it was alive; but he obtains little information as to how these proximate constituents, as they are called, are built up into the living substance of the cell. But if we consider the matter it will be evident that the phenomena of life depend on changes occurring in the interactions of particles of matter far too small even to be seen by the microscope. The physicist and the chemist have not been content with the investigation of large masses of dead matter, but to explain many phenomena they have had recourse to the conceptions of molecules and atoms and of the dynamical laws that regulate their movements. Thus the conception of a gas as consisting of molecules having a to-and-fro motion, first advanced by Krönig in 1856 and by Clausius in 1857, has enabled physicists to explain in a satisfactory manner the general phenomena of gases, such as pressure, viscosity, diffusion, &c. In physiology few attempts have been made in this direction, probably because it was felt that data had not been collected in sufficient numbers and with sufficient accuracy to warrant any hypothesis of the molecular structure of living matter, and physiologists have been content with the microscopic and chemical examination of cells, of protoplasm, and of the simpler tissues formed from cells. An exception to this general remark is the well-known hypothesis of Du Bois-Reymond as to the existence in muscle of molecules having certain electrical properties, by which he endeavoured to explain the more obvious electrical phenomena of muscle and nerve. The conception of gemmules by Darwin and of biophors by Weismann are examples also of a hypothetical method of discussing certain vital phenomena.

The conception, however, of the existence in living matter of molecules has not escaped some astute physicists. The subject is discussed with his usual suggestiveness by Clerk Maxwell in the article Atom in the "Encyclopædia Britannica" in the volume published in 1875, and he places before the physiologist a curious dilemma. After referring to estimates of the diameter of a molecule made by Loschmidt in 1865, by Stoney in 1868, and by Lord Kelvin (then Sir W. Thomson) in 1870, Clerk Maxwell writes:—

"The diameter and the mass of a molecule, as estimated by these methods, are, of course, very small, but by no means infinitely so. About two millions of molecules of hydrogen in a row would occupy a millimetre, and about two hundred million million million of them would weigh a milligramme. These numbers must be considered as exceedingly rough guesses; they must be corrected by more extensive and accurate experiments as science advances; but the main result, which appears to be well established, is that the determination of the mass of a molecule is a legitimate object of scientific research, and that this mass is by no means immeasurably small.

"Loschmidt illustrates these molecular measurements by a comparison with the smallest magnitudes visible by means of a microscope. Nobert, he tells us, can draw 4000 lines in the breadth of a millimetre. The intervals between these lines can be observed with a good microscope. A cube, whose side is the 4000th of a millimetre, may be taken as the *minimum visible* for observers of the present day. Such a cube would contain from 60 to 100 million molecules of oxygen or of nitrogen; but since the molecules of organised substances contain on an average about fifty of the more elementary atoms, we may assume that the smallest organised particle visible under the microscope contains about two million molecules of organic matter. At least half of every living organism consists of water, so that the smallest living being visible under the microscope does not contain more than about a million organic molecules. Some exceedingly simple organism may be supposed built up of not more than a million similar molecules. It is impossible, however, to conceive so small a number sufficient to form a being furnished with a whole system of specialised organs.

"Thus molecular science sets us face to face with physiological theories. It forbids the physiologist from imagining that structural details of infinitely small dimensions can furnish an explanation of the infinite variety which exists in the properties and functions of the most minute organisms.

"A microscopic germ is, we know, capable of development into a highly organised animal. Another germ, equally microscopic, becomes when developed an animal of a totally different kind. Do all the differences, infinite in number, which distinguish the one animal from the other arise each from some difference in the structure of the respective germs? Even if we admit this as possible, we shall be called upon by the advocates of pangenesis to admit still greater marvels. For the microscopic germ, according to this theory, is no mere individual but a representative body, containing members collected from every rank of the long-drawn ramification of the ancestral tree, the number of these members being amply sufficient not only to furnish the hereditary characteristics of every organ of the body and every habit of the animal from birth to death, but also to afford a stock of latent gemmules to be passed on in an inactive state from germ to germ, till at last the ancestral peculiarity which it represents is revived in some remote descendant.

"Some of the exponents of this theory of heredity have attempted to elude the difficulty of placing a whole world of wonders within a body so small and so devoid of visible structure as a germ by using the phrase structureless germs. Now one material system can differ from another only in the configuration and motion which it has at a given instant. To explain differences of function and development of a germ without assuming differences of structure is, therefore, to admit that the properties of a germ are not those of a purely material system."

The dilemma thus put by Clerk Maxwell is (first) that the germ cannot be structureless, otherwise it could not develop into a future being, with its thousands of characteristics; or (second) if it is structural it is too small to contain a sufficient number of molecules to account for all the characteristics that are transmitted. A third alternative might be suggested, namely, that the germ is not a purely material system, an alternative that is tantamount to abandoning all attempts to solve the problem by the methods of science.

It is interesting to inquire how far the argument of Clerk Maxwell holds good in the light of the knowledge we now possess. First, as regards the *minimum visible*. The smallest particle of matter that can now be seen with the powerful objectives and compensating eyepieces of the present day is between the $\frac{1}{400000}$th and the $\frac{1}{500000}$th of a inch, or $\frac{1}{20000}$th of a millimetre in diameter, that is to say, five times smaller than the estimate of Helmholtz of $\frac{1}{4000}$th of a millimetre. The diffraction of light in the microscope forbids the possibility of seeing still smaller objects, and when we are informed by the physicists that the thickness of an atom or molecule of the substances investigated is not much less than a millionth of a millimetre, we see how far short the limits of visibility fall of the ultimate structure of matter.

Suppose, then, we can see with the highest powers of the microscope a minute particle having a diameter of $\frac{1}{20000}$th of a millimetre, it is possible to conceive that some of the phenomena of vitality may be exhibited by a body even of such small dimensions. The spores of some of the minute objects now studied by the bacteriologist are probably of this minute size, and it is possible that some may be so minute that they can never be seen. It has been observed that certain fluids derived from the culture of micro-organisms may be filtered through thick asbestos filters, so that no particles are seen with the highest powers, and yet those fluids have properties that cannot be explained by supposing that they contain toxic substances in solution, but rather by the assumption that they contain a greater or less number of organic particles so small as to be microscopically invisible. I am of opinion, therefore, that it is quite justifiable to assume that vitality may be associated with such small particles, and that we have by no means reached what may be called the vital unit when we examine either the most minute cell or even the smallest particle of protoplasm that can be seen. This supposition may ultimately be of service in the framing of a theory of vital action.

Weismann in his ingenious speculations has imagined such a vital unit to which he gives the name of a biophor, and he has even attempted numerical estimates. Before giving his figures let us look at the matter in another way. Take the average diameter of a molecule as the millionth of a millimetre, and the smallest particle visible as the $\frac{1}{20000}$th of a millimetre. Imagine this small particle to be in the form of a cube. Then there would be in the side of the cube, in a row, fifty such molecules, or in the cube $50 \times 50 \times 50 = 125{,}000$ molecules. But a molecule of organised matter contains about fifty elementary atoms. So that the 125,000 molecules in groups of about fifty would number $\frac{125000}{50} = 2500$ organic particles. Suppose, as was done by Clerk Maxwell, one half to be water; there would remain 1250 organic particles. The smallest particle that can be seen by the microscope may thus contain as many as 1250 molecules of such a substance as a proteid.

Weismann's estimates as to the dimensions of the vital unit to which he gives the name of biophor may be shortly stated. He takes the diameter of a molecule at $\frac{1}{20000000}$th of a millimetre (instead of the one millionth) and he assumes that the biophor contains 1000 molecules. Suppose the biophor to be cubical, it would contain ten in a row, or $10 \times 10 \times 10 = 1000$. Then the diameter of the biophor would be the sum of ten molecules, or $\frac{1}{20000000} \times 10 = \frac{10}{20000000}$ or $\frac{1}{2000000}$th of a millimetre. Two hundred biophors would therefore measure $\frac{200}{2000000}$ or $\frac{1}{1000}$ mm. or 1 μ (micron $= \frac{1}{1000}$th mm.). Thus a cube one side of which was 1 μ would contain $200 \times 200 \times 200 = 8{,}000{,}000$ biophors. A human red blood corpuscle measures about 7·7 μ; suppose it to be cubed, it would contain as many as 3,652,264,000 biophors.

Now if the smallest particle that can be seen ($\frac{1}{20000}$th mm.) may contain 1250 molecules, let us consider how many exist in a biophor, which we may imagine as a little cube, each side of which is $\frac{1}{2000000}$th mm. There would then be five in a row of such molecules, or in the cube $5 \times 5 \times 5 = 125$ molecules; and if the half consisted of water about sixty molecules.

Let us apply these figures to the minute particles of matter connected with the hereditary transmission of qualities. The diameter of the germinal vesicle of the ovum is $\frac{1}{20}$th of a millimetre. Imagine this a little cube. Taking the diameter of an atom at $\frac{1}{10000000}$th of a millimetre, and assuming that about fifty exist in each organic molecule (proteid, &c.), the cube would contain at least 25,000,000,000,000 organic molecules. Again, the head of the spermatozoid, which is all that is needed for the fecundation of an ovum, has a diameter of about $\frac{1}{200}$ mm. Imagine it to be cubed; it would then contain 25,000,000,000 organic molecules. When the two are fused together, as in fecundation, the ovum starts on its life with over 25,000,000,000,000 organic molecules. If we assume that one half consists of water, then we may say that the fecundated ovum may contain as many as about 12,000,000,000,000 organic molecules. Clerk Maxwell's argument that there were too few organic molecules in an ovum to account for the transmission of hereditary peculiarities does not apparently hold good. Instead of the number of organic molecules in the germinal vesicle of an ovum numbering something like a million, the fecundated ovum probably contains millions of millions. Thus the imagination can conceive of complicated arrangements of these molecules suitable for the development of all the parts of a highly complicated organism, and a sufficient number, in my opinion, to satisfy all the demands of a theory of heredity. Such a thing as a structureless germ cannot exist. Each germ must contain peculiarities of structure sufficient to account for the evolution of the new being, and the germ must therefore be considered as a material system.

Further, the conception of the physicist is that molecules are more or less in a state of movement, and the most advanced thinkers are striving towards a kinetic theory of molecules and of atoms of solid matter which will be as fruitful as the kinetic theory of gases. The ultimate elements of bodies are not freely movable each by itself; the elements are bound together by mutual forces, so that atoms are combined to form molecules. Thus there may be two kinds of motion, atomic and molecular. By molecular motion is meant "the translatory motion of the centroid of the atoms that form the molecule, while as atomic motion we count all the motions which the atoms can individually execute without breaking up the molecule. Atomic motion includes, therefore, not only the oscillations that take place within the molecule, but also the rotation of the atoms about the centroid of the molecule." [1]

Thus it is conceivable that vital activities may also be determined by the *kind* of motion that takes place in the molecules of what we speak of as living matter. It may be different in kind from some of the motions known to physicists, and it is conceivable that life may be the transmission to dead matter, the molecules of which have already a special kind of motion, of a form of motion *sui generis*.

I offer these remarks with much diffidence, and I am well aware that much that I have said may be regarded as purely speculative. They may, however, stimulate thought, and if they do so they will have served a good purpose, although they may afterwards be assigned to the dust-heap of effete speculations. Meyer writes as follows in the introduction to his great work on "The Kinetic Theory of Gases," p. 4:—"It would, however, be a considerable restriction of investigation to follow out only those laws of nature which have a general application and are free from hypothesis; for mathematical physics has won most of its successes in the opposite way, namely, by starting from an unproved and unprovable, but probable, hypothesis, analytically following out its consequences in every direction, and determining its value by comparison of these conclusions with the result of experiment."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SIR PHILIP MAGNUS will distribute the prizes to students of the Morley Memorial College, Waterloo Road, on October 1.

THE Report of the Board of Education, reviewing the proceedings of the Board for the year which ended with last year, has been published as a Blue-book. Reference is made to the Committee appointed to consider the best means of coordinating the technological work of the Board with that at present carried on by other educational organisations. The report of the Committee was received some time ago, and is now "under consideration." It is to be hoped that the report will soon be issued and action taken upon it.

SCIENTIFIC SERIALS.

The American Journal of Science, September.—The discharge current from a surface of large curvature, by John E. Almy. It was found that the current discharging from a fine wire to a concentric cylinder is given by the equation

$$I = LaV(V - b)/r^3,$$

where I is the discharge current, V is the potential difference between the wire and cylinder, L is the length of the discharge wire, r the radius of the cylinder, b the minimum potential necessary to produce a measurable discharge, and a a constant depending upon the size of the wire, the nature of the discharging gas and the sign of the discharge.—On octahedrite and brookite from Brindletown, North Carolina, by H. H. Robinson.—On the behaviour of small closed cylinders in organ pipes, by B. Davis. When small gelatine capsules or light paper cylinders were placed in a stopped organ pipe, on sounding the pipe the cylinders immediately moved to the middle of the stationary loop and arranged themselves in rows across the pipe. The effects produced were of the same nature as the Kundt dust figures.—On a cæsium-tellurium fluoride, by H. L. Wells and

[1] Meyer, "Kinetic Theory of Gases." Translated by Baynes, London, 1899, p. 6.

J. M. Willis. Only one double fluoride could be obtained of the formula $CsF.TeF_4$.—On the double chlorides of cæsium and thorium, by H. L. Wells and J. M. Willis.—Studies of Eocene mammalia in the Marsh collection, Peabody Museum, by J. L. Wortman.—On the separation of the least volatile gases of atmospheric air and their spectra, by G. D. Liveing and J. Dewar (from the *Proceedings* of the Royal Society).—The estimation of calcium, strontium and barium as their oxalates, by C. A. Peters. In the estimation of calcium by titration of the oxalate with permanganate accurate results may be obtained when hydrochloric acid (with a manganous salt) is used as a solvent. The conditions have also been worked out under which barium and strontium can be accurately estimated as oxalates.—On calaverite, by S. L. Penfield and W. E. Ford.

Transactions of the American Mathematical Society, July.—On the convergence of continued fractions with complex elements, by E. B. Van Vleck. Few theorems of a general character have hitherto been obtained, and these but of recent date. The present paper recapitulates these, and some new criteria are deduced. The demonstrations are based upon certain equations which the writer believes to be new and of a fundamental character. The references to previous memoirs form a useful feature.—Geometry within a linear spherical complex, by P. F. Smith, is a paper devoted to the study of a point-sphere correspondence of involutory character, which appears as a direct generalisation from a certain point of view of the well-known point-sphere correspondence arising in a dilatation and the point-point correspondence of spherical inversion. Illustrative problems are discussed.—A new determination of the primitive continuous groups in two variables, by H. F. Blichfeldt. These groups can, by a proper choice of the variables, be transformed into *projective groups* of the plane, a result which Lie obtains after determining the canonical forms of the primitive groups. This fact can, however, be established from the general properties of such groups, and its use leads to a new determination which it is the object of the paper to show.—Determination of all the groups of order p^m which contain the Abelian group of type $(m-2,1)$, p being any prime, by G. A. Miller.—On a fundamental property of a minimum in the calculus of variations, and the proof of a theorem of Weierstrass's, by W. F. Osgood.—Concerning Harnack's theory of improper definite integrals, by E. H. Moore. The paper considers the improper simple definite integrals of Harnack (1883, 1884), and opens with a capital introduction to the bibliography of the subject.—Zur linearen transformation der ϑ-reihen, by F. Mertens.—All the papers were presented at different meetings of the American Mathematical Society, ranging from October 1900 to July 1901.

SOCIETIES AND ACADEMIES.

NEW SOUTH WALES.

Linnean Society, July 31.—Mr. J. H. Maiden, president, in the chair.—Further notes on supposed hybridisation among the Eucalypts: with the description of a new species, by Henry Deane and J. H. Maiden.—Notes on the botany of the interior of New South Wales, part iv., by R. H. Cambage. The country particularly referred to comprises the district between Mount Hope and Parkes, the route traversed generally following the very low range which forms the watershed between the Lachlan and the Bogan Rivers. Mallees were found to be numerous near Mount Hope, but had ceased before Parkes was reached. *Eucalyptus conica*, Deane and Maiden, and *E. albens* were met with near Trundle.—Contributions to a knowledge of Australian Entozoa, part i., description of a new species of *Distomum* from the Platypus, by S. J. Johnston. *Distomum ornithorhynchi*, n.sp., is found in the stomach, duodenum and proximal portion of the small intestine of the duckbill. The species falls into Dujardin's subgenus *Brachylaimus*.—Revised census of the marine mollusca of Tasmania, by Prof. Ralph Tate and W. L. May. By far the greater number of the named species of Tasmania have been known by description only, covered by the papers of Tenison-Woods, 1875–81, and continued by Petterd and Beddome to 1884; and in consequence many of the species have been re-described under different names. The efforts of the authors, carried on for many years, are to bring these little known species into relationship with the constituents of neighbouring local faunas. The authors have had access to very nearly all of the local types, and their knowledge of the Australian fauna imparts to their interpretation of the Tasmanian species a value which may be accepted as correct in the main. The unfigured species, including about 30 new forms, number 120 or thereabouts, which are illustrated. Two new genera are established, *Petterdella*, based on *Stylifer Tasmanica*, T.-Wds., which has the general form and aperture of *Rissoina* and the heterostrophe nucleus of *Eulimella*; and *Thraciopsis* (nomen mutandum) = *Alicia*, Angas *non* Johnston (1861). A new species of a previously unknown genus in Australia, *Cyamium*, is described. Among some of the several changes in generic location is the transference of *Cominella tenuicostata* to *Phos* in a sectional group belonging to the Older Tertiaries of Australia. This is not the only instance of the survival of an Eocene genus in an unique species in the waters of Southern Australia and Tasmania. The number of species in the census of Tenison-Woods has been considerably reduced, but many extralimital species have been added. The total number is 676, grouped as follows:—Cephalopoda, 10; Gastropoda, 503; Scaphopoda, 4; Lamellibranchiata, 156: Palliobranchiata, 3.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part 1 for 1901, contains the following memoirs communicated to the Society:—

January 12.—W. Voigt: on the pyromagnetism and piezomagnetism of crystals.

February 23.—W. Boy: on the representation of the projective plane on a finite closed surface free from singularities.

March 9.—E. Zermelo: on the addition of transfinite cardinal numbers. H. Liebmann: on the flexure of the closed ring-surface. W. Nernst and E. H. Riesenfeld: on electrolytic phenomena at the common surface of two solvents. W. Kaufmann: on an analogy between the behaviour of Nernst's "incandescent oxides" and that of conducting gases.

May 11.—Emil Cohn: on the equations of the electromagnetic field for bodies in motion.

The *Minutes* of the Society contain brief reports on the progress of the Mathematical Encyclopædia, and of the new edition of Gauss's works, together with an obituary notice of Prof. Max Müller.

CONTENTS.

THURSDAY, OCTOBER 3, 1901.

A SCIENTIFIC ENGINEER.

Papers on Mechanical and Physical Subjects. By Prof. Osborne Reynolds, F.R.S. Vol. ii. 1881–1900. Pp. xii+740. (London: C. J. Clay and Sons, 1901.) Price 21*s*. net.

A FULL account of the first volume of Prof. Osborne Reynolds' collected papers has already appeared in these pages (vol. lxii. p. 243). The second volume, which is no less interesting than its predecessor, brings the author's contributions to mechanical science up to date and enables us to realise the value of the work he has done. The twenty-seven papers here printed vary, no doubt, in importance; but throughout them all Prof. Reynolds has kept one aim clearly in view, the application of physical and mechanical principles to engineering problems; whether he is dealing, as in the first paper, with the question of the fundamental limits of speed or, as in the last, with the reasons why ice is slippery, this aim is always before the author.

It is difficult from a volume of this kind to make a selection of points to notice; there are, however, three papers which stand out conspicuously as dealing in a luminous manner with three fundamental problems. The first is No. 44, an experimental investigation of the circumstances which determine whether the motion of water shall be direct or sinuous, and of the law of resistance in parallel channels. The second, No. 52, on the theory of lubrication and its application to Mr. Beauchamp Tower's experiments, and the third, No. 66, on the method, appliances and limits of error in the direct determination of the work expended in raising the temperature of ice-cold water to that of water boiling under a pressure of 29·899 inches of ice-cold mercury in Manchester. A few lines may be given to each of these in turn.

The fact that for narrow tubes and for small velocities the resistance to the flow of water in a tube is proportional to the velocity follows from the experiments of Poiseuille and others. It was also known that this law did not hold in larger tubes or when the velocity was considerably increased, but the cause of the change and the relation of the velocity to the radius for which it occurred in a given tube were unknown until the date of Prof. Reynolds' experiments. He showed that if D be the diameter of the tube, V the velocity of the stream and P the ratio of the coefficient of viscosity to the density, then the change of resistance takes place at a velocity V given by the equation $V = P/BD$ when B is a constant, and, moreover, that at this critical velocity the motion of the water in the tube changes from direct to sinuous; eddies and vortices are set up which are intimately connected with the change in resistance. Further experiments showed that up to the critical velocity the slope of pressure in the tube varies as the velocity, while for velocities considerably greater than the critical the slope of pressure varies as the velocity raised to the power of 1·72.

The second paper deals with Mr. Tower's experiments on lubrication. Mr. Tower had shown that when the rubbing surfaces, the friction between which was being investigated, were totally immersed in oil, a thin film of oil was formed between them, within which the pressure was enormously greater than in the oil bath; in some cases it was as much as 625 lbs. to the square inch above the pressure in the bath.

Prof. Reynolds gives a very complete account of the existence of this film and of the conditions for complete and incomplete lubrication.

In the last paper mentioned the author gives the theory of a very valuable redetermination of Joule's equivalent.

The laboratory at the Owens College is fitted with a set of triple expansion engines which can be arranged to work on three special hydraulic brake dynamometers, the energy being absorbed by a stream of water which passes through the brake. This water can be taken from a tank holding some 60 tons in a tower 116 feet above the laboratory floor.

The experiment, put briefly, consisted in measuring the work put into the brake, the temperature of the incoming and outflowing water and the quantity of that water. Prof. Reynolds' paper contains a detailed exposition of the theory, with an account of the precautions taken and calculations required to allow for the various sources of error.

The experiments were conducted by Mr. Moorby, and are very closely concordant. It results from them that the mean specific heat of water between freezing and boiling points is 776·94 ft. lbs., or in C.G.S. units 41832000 ergs.

Other papers of great interest and importance might easily be mentioned; for these we must refer the reader to the book itself, at the same time congratulating the author on the conclusion of the task he was asked to undertake and the Cambridge University Press on the service it is rendering to science by its series of reprints of mathematical and physical papers.

NORTH AMERICAN INSECTS.

The Insect Book: a Popular Account of the Bees, Wasps, Ants, Grasshoppers, Flies, and other North American Insects, exclusive of the Butterflies, Moths, and Beetles, with full Life-histories, Tables and Bibliographies. By Leland O. Howard, Ph.D., Chief of the Division of Entomology, U.S. Department of Agriculture. Pp. xxvii+429; 47 plates (plain and coloured), and 264 woodcuts. (New York: Doubleday, Page and Co., 1901.) Price 3 dollars net = 12*s*.

IN the preface to Dr. Holland's admirable "Butterfly Book," the author mentioned that he might subsequently issue a similar work on the moths. The book before us is uniform with Dr. Holland's, who is, as Dr. Howard informs us in his preface, engaged on the promised volume of moths, while another volume on the beetles is in contemplation, we presume by, or under the supervision of, Dr. Howard, though this is not explicitly stated.

Enormous strides have been made in the study of North American entomology during the last forty years, and there must now be a very considerable number of entomologists in the country. No doubt many of these devote themselves to the popular orders of Lepidoptera and Coleoptera, as in Europe; but nevertheless there are numerous active workers, known or unknown, in all the so-called "neglected orders," and a popular manual on these insects, freely illustrated, must greatly conduce to their more extended study, though it is, of course, impossible to treat of five great orders of insects in a single volume in anything like so complete a manner as Dr. Holland was able to achieve for the limited group of butterflies. Dr. Howard has, however, contrived to bring together and condense a large amount of very useful information from various sources, and his book should prove nearly as valuable to European as to North American entomologists; for not only are a large proportion of the various families and genera common to both countries, but a considerable number even of the species here described and figured are common and well-known British species. Here and there we find a slip, as when the number of described species of Hymenoptera is estimated on the first page as nearly 30,000, whereas it almost certainly exceeds 40,000 at the present time; and at p. 345 the exploded superstition originated by Kirby and Spence that earwigs do *not* enter the human ear seems to be insisted on. Perhaps the rarity of earwigs in the States may partly account for this.

We have already said that some of the species included in this work are common British species. Others are large and handsome forms quite unlike any existing in England, or perhaps in Europe. This is especially the case in the orders Orthoptera and Neuroptera; and the pretty plates of dragonflies, especially plates 40 and 43, representing species with coloured wings, will be something like a revelation to the entomologist familiar only with the hundred European species of dragonflies, not more than three or four of which have any considerable amount of colour in the wings, though this is partly atoned for by the bright colours of their bodies.

Most, if not all, of the figures in the plates are probably original; but most of the text illustrations are copied from Riley, Packard, Comstock and other well-known writers.

As is usual with recent American writers, Dr. Howard admits several more families of insects than the seven with which most of our English entomologists are satisfied. Tables of families are given in several of the orders, which will greatly facilitate the work of a beginner. Otherwise, however, there is little technical matter in the book, which mainly consists of descriptions of habits and transformations. There is a good deal of light readable matter; and Mr. Marlatt's account of the way in which boys in Kansas rob humble-bees' nests by enticing the bees into a jar half filled with water will be equally new and amusing to most English readers.

Turning to the end of the volume, we find a good but not too extensive index of thirteen pages, double columns, preceded by a bibliography of twelve pages, very closely printed in double columns, and arranged systematically in a manner that seems a little puzzling till one gets used to it. This will prove a most useful part of the book to serious workers, and it brings out very forcibly the enormous periodical literature to which Dr. Howard alludes in his preface and which is so conspicuous a eature of the American entomological literature of the present day. The bibliography is preceded by a section on "Collecting and Preserving Insects," freely illustrated in the text, like the rest of the book, which, although primarily written for American entomologists, may also furnish useful hints to European collectors.

We cannot do less than strongly recommend Dr. Howard's book to all entomologists who are interested in theorders of insects to which it refers, repeating that the main features of the book are the detailed life-histories and the number of good illustrations of the insects discussed.

OUR BOOK SHELF.

Nature Teaching. By Francis Watts, F.I.C., F.C.S. Pp. 199. (London: Dulau and Co. Barbados: Bowen and Sons.)

THIS is a very useful volume, issued under the authority of the Imperial Commissioner of Agriculture for the West Indies. It is based upon the general principles of agriculture, and has been designed for the use of schools in the islands. Although these colonies depend entirely on the proper cultivation of the soil, there has hitherto been practically no attempt made to impart to the rising generation a knowledge of even the elements of agriculture. Like everything else in the mother country and in Britain across the seas, the rule of thumb, happy-go-lucky system has been preferred to scientific methods, with the result that we are all being left behind in the race. The Imperial Commissioner notes that one of the most hopeful features connected with the West Indies is the general movement which is now taking place in favour of agricultural teaching. Teachers in charge of schools have during the past three years been undergoing training sufficient to enable them to impart a fair knowledge of botanical principles to their scholars, and the volume now prepared by Mr. Watts, with the assistance of Mr. Maxwell-Lefroy, is intended to guide the teachers in the way they should go. The work is divided into nine chapters, dealing respectively with the seed, the root, the stem, the leaf, the soil, plant food and manures, flowers and fruits, weeds, and insects. Simple language is used in describing each subject, and every chapter ends with copious instructions on practical work. Thus the chapter on the seed deals with the parts of a seed; plant food in seeds; and germination; while under "practical work" we find described the conditions for germination; raising seedlings; seed beds; observations on seedlings; and testing vitality of seeds. A glossary and appendices are added. The book is not intended as an ordinary reading-book, but for the use of the older pupils who have already received oral instruction in the various subjects.

Cassell's Eyes and No Eyes Series. Book I. *Wild Life in Woods and Fields.* Pp. 48. Book II. *By Pond and River.* Pp. 48. Book III. *Plant Life in Field and Garden.* Pp. 80. Book IV. *Birds of the Air.* Pp. 79. By Arabella B. Buckley (Mrs. Fisher). (London: Cassell and Co., 1901.) Price, Books I. and II., 4*d.* each; Books III. and IV., 6*d.* each.

THESE attractive little books will promote an intelligent interest in plants and animals among the children who read them. In very simple words Mrs. Fisher describes some insects, birds, flowers, and other living things familiar to observers of outdoor nature, and her descriptions will doubtless direct the attention of many pupils to natural history studies. Each book has several nicely coloured plates in addition to numerous other illustrations. In rural schools the books should be of exceptional value.

LETTER TO THE EDITOR.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Long-tailed Japanese Fowls.

WITH reference to my previous letter on this subject, I should like to draw the attention of the readers of NATURE to a very interesting paper in the *Transactions* of the Asiatic Society of Japan (vol. xxvii. 1900). The writer, Mr. Basil Hall Chamberlain, who has obtained his information from a Japanese fancier, Mr. Kitagawa Ushimatsu, and has also examined the birds himself, states that "there is absolutely no artificial method of making the feathers grow. All is done by selection. Any failure to obtain good results must proceed from having a bad hen, that is, one not of the true breed, and it is in this point that buyers are liable to be deceived. Also one must know how to treat the birds."

The long tail-feathers, Mr. Chamberlain states, grow during the whole life of the bird, which may extend to eight or nine years. If accidentally pulled out they are reproduced. The rate of growth is about four inches a month in young birds, but as much as seven inches in older specimens. The custom of tying up the tail is stated to be a mistaken one, and not to be followed where the birds are bred. The very best specimens are, not unnaturally, kept at home by the breeders in the Tosa province.

The breed is believed to be about a century old, but its origin is unknown. But it seems obvious from the evidence given that it was bred from birds which "sported" in the direction of continuously-growing feathers, as I suggested. Mr. Chamberlain's paper is illustrated by two excellent photographs of cocks of this breed, one of which at least is evidently far superior to the specimens exhibited at South Kensington, remarkable as these are.

FRANK FINN.

c/o Zoological Society, 3, Hanover-square.

PROF. A. F. W. SCHIMPER.

WILHELM ANDRÉ SCHIMPER, who passed away on September 9 in his forty-sixth year, was the great son of an eminent father. Inheriting from his father, the professor of botany, and from the Abyssinian traveller Schimper, a famous name, he made that name yet more famous.

Schimper studied at the University initially, I believe, with the intention of becoming a mineralogist; and his first paper, on proteid crystals (1879), bears the impress of his special training. But this paper, as well as an early one (issued 1880) on a parasitic flowering plant, *Prosopanche*, has been overshadowed by his later achievements.

It was not until the appearance of his paper on the origin of starch (1880) that the botanical world became aware that a young botanist of power and originality had joined it. Before the appearance of this paper the view prevailed that starch-grains were manufactured either by chlorophyll grains or by the general protoplasm. Schimper showed that starch-grains are invariably produced in specialised masses of protoplasm, in chlorophyll grains, or in colourless "starch-builders." Continuing his researches (1880–1885), he, together with Schmitz, proved that chloroplasts, exclusively by division, arise from preexisting ones (or their homologues), but never by a formation *de novo* from the general protoplasm. Schimper further demonstrated the homology of the three classes of chromatophores—leucoplasts (without colouring matter), chloroplasts (with chlorophyll), and chromoplasts (with red or yellow colouring matter). In fact, while other histologists were showing that the plant-cell and animal-cell had two distinct and individualised kinds of protoplasm—cytoplasm and nucleus—Schimper was demonstrating that a third existed, which, like the other two, could produce, and only be produced by, its like. In other words all (or at least nearly all) indubitable animals possess in their cells only two completely distinct kinds of protoplasm, whereas all indubitable plants, with the exception of fungi, and possibly some of the lowest vegetable organisms, have three kinds; and it is to the possession of this third kind of protoplasm—chromatophore-protoplasm—that the plant world largely owes its evolution.

But Schimper's investigations on starch-grains incidentally aided in the inception of another, though minor, revolution in botanical thought. When Schimper commenced his work on the origin of starch, Naegeli's theory of growth of the cell-wall by intussusception was firmly held. Schimper's observations and considerations on the growth of starch grains, and some of Schmitz's observations, were the first blows struck at Naegeli's theory, in favour of growth by apposition, and doubtless they stimulated Strasburger to furnish his masterly case in support of the latter view.

Not to adopt strict chronological order, but to follow Schimper's researches so far as they dealt with pure physiology or histology, the next paper, on the conduction of carbohydrates (1885), was of value, as an exhibition of a strict physiological method, and as an appeal against the alluring and facile method of endeavouring to solve physiological problems solely by histological observations, rather than as a paper containing essentially new physiological views. Schimper's two succeeding physiological papers, on the formation of calcium oxalate in leaves (1887), and the assimilation of mineral salts (1890), were of greater importance. They introduced the method of following by microchemical tests the various inorganic elements in their course from the root to the leaves. Apart from serving as admirable and novel models of physiological research, these papers proved that the leaves are no mere workshops for the manufacture of carbohydrates, but that they are in reality perfectly equipped factories in which the rawest food materials can be, and are, worked up into elaborate proteid compounds, and even into protoplasm. Schimper further showed that chlorophyll, in addition to affecting the decomposition of carbon dioxide and the production of carbohydrates, also in some way influences the reduction of inorganic salts and the production of proteids, apparently in a direct manner.

Despite the value of his contributions to our knowledge of the histology and physiology particularly of green cells, Schimper's fame is possibly wider as the founder of a true method of investigating the "politics," "biology," "bionomics," or œcology of plants.

Though Sprengel, Darwin, H. Müller and others had set so excellent an example in their treatment of questions relating to the pollination of flowers, in other departments of the subject the œcology of plants was mainly a motley array of ill-considered hypotheses, vain phantasies and unfounded conclusions, and by serious botanists the subject was derided as the "romance of botany." Schimper inaugurated a new era. In dealing with problems on the relation between plants and their environments, he insisted that the same thoroughness and precision should be exercised as in investigating morphological and physiological questions.

Schimper's first œcological paper, on epiphytes (1884), was a veritable revelation, magic as a fairy-story in interest, but severely reasoned in substance. In this, and in its final version (1891), it was shown that epiphytes were children of the moist forests, and had arisen as beings that had won a victory in the struggle for light by seizing positions of vantage with very little expenditure of material. Commencing as humble occupants of the soil within the shady forest, epiphytes had in the course of ages laboriously clambered up the trees, striving after the light, and ever struggling against the precarious and fluctuating supplies of moisture and of humus, inventing new absorbing and fixing organs, and contriving fresh devices for resisting threatened death from thirst or starvation, until at length their perilous career was crowned with success and they formed aërial meadows, gardens, shrubberies, and even forests. Schimper showed that the evolution of epiphytes was still reflected in the forest, where the simplest epiphytes lurk low down in moist shaded crevices of the tree trunks, and the more elaborate ones are ranged successively upwards until, even before the tree-tops are reached, perfection is practically attained. Further, he taught how, having emerged into the full blaze of the tropical sun, some epiphytes had sprung across to the savannahs, where they colonised the isolated trees or clothed the nakedness of the bare rocks. And still later he carried the history one step further and revealed some epiphytes flying up to the mountain-tops and others leaping down to the ground near the sea.

The next œcological paper, that on myrmecophilous plants (1888), furnished relatively little that was new, but by the application of a strict method of research it definitely proved views that had been promulgated by that sagacious naturalist, Belt.

The very brief communication on the means of protection against transpiration (1890) was possibly the most suggestive ever issued by Schimper. In it he explained that terrestrial plants living on or near the sea shore, even in saline swamps, or growing inland in the vicinity of salt springs, require to protect themselves against excessive transpiration owing to the difficulty in obtaining a sufficient supply of water with or without salt. Further, he pointed out that Alpine plants in the tropics, at spots where there is no snow, reveal the same xerophilous character as in temperate regions, and it is against desiccation due to exalted transpiration, and not against cold as such, that Alpine plants have to battle. Finally he directed attention to the fact that in temperate regions deciduous trees shed their leaves because they cannot absorb water sufficiently rapidly from the cold soil; whereas evergreen trees can retain their foliage because of the xerophytic structure of the latter. (Though he was not aware of the fact, Schimper was not the actual discoverer of this truth, for I find that Hales appreciated it.) These considerations led to the solution of several geographical problems. They explained how, in temperate and tropical regions alike, Alpine plants may reappear on the sea shore; how, in the tropics, epiphytes reappear as terrestrial plants on Alpine heights, on the sea shore, or near salt-springs. These plants can interchange positions because they are all adapted to resist one danger—excessive transpiration.

In his last œcological paper on a special subject—the Indo-Malayan littoral vegetation (1891)—the principles enunciated in the preceding work were proved and expanded, and other relations between littoral plants and their animate and inanimate surroundings were dealt with. It is impossible to do justice to this paper in a brief note, but it may be mentioned that the important distinction between salt-loving and salt-hating plants was shown to refer, not merely to plants growing on the shores or inland respectively, but to whole orders or cohorts. Littoral plants, then, are salt-enduring representatives that have been driven by competition to the fringe of vegetation, where they have evolved new features in their vegetative and reproductive parts in order that they may exist and spread abroad from shore to shore.

Schimper's last book, a general work on geographical distribution of plants considered from a physiological standpoint, is beyond doubt one of the most illuminating botanical works ever published. No one save a wide traveller, inspired with a deep love for, and close sympathy with, Nature could have written this masterpiece. It was the crowning piece of his life, for Schimper was stricken down in the midst of a new work on island floras.

In conclusion we may say that Schimper revolutionised our ideas as to the fundamental constitution of the unit of plant life, widened and deepened our knowledge of the physiology of green assimilating cells, and, himself in every field in which he worked an earnest advocate, and even inventor, of strict methods of research, he, in particular, took a foremost place in raising up a true science of œcology. Through the passing of Schimper the world of science is darker by the extinction of a light which, if it did not glow with steady incandescence, yet quivered and scintillated with genius.

PERCY GROOM.

NOTES.

INTRODUCTORY addresses were delivered on Tuesday at several of the London and provincial medical schools, to open the new session. Dr. P. W. Latham, speaking at St. George's Hospital, pointed out that organic chemistry will in time tell exactly what is the composition and constitution of toxins, albumoses, antitoxins, &c., which have proved of service to medicine, and how they may be artificially synthesised in the laboratory. The vegetable alkaloids quinine, morphine and atropine, have been isolated within the last century; and the syntheses of citric acid and indigo have been effected from their elements. The isolation of the animal alkaloids may be more difficult, but it will be accomplished—some have already been obtained, others will follow; the isolation of the antitoxins will be the next chemical triumph, and then will come the synthetical production of these life-saving substances. At University College, Prof. R. Russell begged his hearers to cultivate the spirit of scientific inquiry. Every scientific investigation, if properly conducted, might be expected to disclose some new fact, and this was the only way in which true progress could be made. It was to men of science that every real fresh advance in medicine was due. The so-called practical man could do little more than apply and utilise the discoveries of the investigator. A belief prevalent among some people, that a man could not be both scientific and practical, and that the cultivation of the one spirit must of necessity be at the expense of the other, he regarded as a great fallacy. Medicine and surgery could only be expected to be advanced by a proper commingling of the scientific and the practical, so that scientific principles might find practical application in the elucidation and treatment of disease. At the London School of Medicine for Women, Dr. F. W. Andrewes also referred to the intimate relation between scientific studies and medical practice. He remarked, for instance, that the methods by which pathology is studied are precisely those used in other pure sciences—observation and experiment—and it is this science which is placing medicine and surgery on a scientific basis. It is obvious that a sound knowledge of disease is an indispensable preliminary to its reasonable treatment. At the Royal Veterinary College, Prof. Crookshank discussed the subject of the relation between human and bovine tuberculosis. Dr. A. P. Luff, at the Pharmaceutical Society, commented upon the too general use of powerful drugs in compressed forms, and of proprietary preparations, in the treatment of disease. Addresses were also given by Dr. W. Hill at St. Mary's Hospital, and Dr. T. H. Kellock at Middlesex Hospital.

THE forty-sixth annual exhibition of the Royal Photographic Society was opened to the public on Monday at the New Gallery, Regent Street, and although the greater part of the available space is occupied by exhibits of the artistic and professional kinds, there is an important section devoted to scientific and technical examples. Among a considerable number of natural history subjects there is a notable series, that has been awarded the Society's medal, by Mr. Douglas English. He shows six frames, each containing three or four different photographs of the brown rat, the common mouse, the wood mouse, the field vole, the bank vole and the water vole respectively. The photographs are not of a haphazard kind, for in spite of the difficulties of the subjects Mr. English has succeeded in giving typical front and side views of each species. A series of waves and ripple marks in water, sand, snow and clouds, by Dr. Vaughan Cornish, and another of typical cloud forms, by Captain D. Wilson-Barker, are good examples of the kind of work that may be done in this direction. M. Henri Becquerel has contributed several interesting examples of the effects of the mysterious rays that emanate from uranium and radium, including their deviation in a magnetic field and the separation of the different kinds of rays. Recent spectrum work of various kinds is also shown. A series of radiographs by Dr. Hall-Edwards is of especial interest as they were made at the Imperial Yeomanry hospitals at Deelfontein and Pretoria a few months ago. They show bullets in different parts of the body, including the chest, and the effects of soft-nosed and expansive bullets. In the Exhibition there will be found a fine collection of examples of various methods of photomechanical work. A panorama of the great working hall of the German Electrical Co. is a remarkable photogravure nearly five feet in length, by Messrs. Meisenbach, Riffarth and Co., but the most notable exhibits in this section are the colour prints. Three-colour prints by the method of superposed films, superposed carbon prints, and the ordinary three-colour typographic work, photogravure in colours and colour collotypes, may be seen at their best. Those who appreciate the curious in this direction may examine gum bichromate prints in three colours, and colour effects produced by exposing gelatino-chloride paper through green leaves. Among the new apparatus the European Blair Camera Co. have contributed their new film cartridge, in which the numbers and dividing marks are simple perforations through white paper, showing the black beneath, and therefore cannot have any effect on the sensitive surface.

THE Cunard steamer *Lucania*, which arrived at Liverpool on Saturday morning, reported that, on September 25, she had been in communication at sea by wireless telegraphy, with the same company's outward bound steamer *Campania*, which left Liverpool on September 21. The ships were 36 miles apart when complimentary messages were exchanged, and were not visible to each other at any time.

THE annual "cryptogamic meeting" of the Essex Field Club will be held on Saturday, October 12, at High Beach, Epping Forest. Dr. M. C. Cooke, Mr. Massee, Prof. Marshall Ward, F.R.S., and other botanists have consented to act as referees. Prof. Marshall Ward will give an address on "The Scientific Study of Fungi." Botanists and others wishing to attend should communicate with the hon. secretary, Mr. W. Cole, Buckhurst Hill, Essex.

WE learn from the *Times* that a statue of Pasteur was unveiled on Sunday at Arbois, where he spent his childhood and where he latterly spent his few holidays. Pasteur's son and his son-in-law, M. Vallery Radot, were present, and almost the whole population of the little town assembled round the statue. M. Decrais, Minister of the Colonies, in a glowing eulogium on Pasteur, stated that in the hope of earning for France the honour of preventing the ravages of yellow fever, Drs. Marchoux and Simon, nominated by the Pasteur Institute, and M. Salimbeni, an eminent Italian, were about to be sent to Brazil to study the malady. M. Liard, of the Institute, also spoke on Pasteur's achievements and character.

PROF. G. SIMS WOODHEAD contributes to the *Monthly Review* an article upon the prevention and cure of tuberculosis, with special reference to the conclusions stated by Prof. Koch in his address to the recent British Congress on Tuberculosis.

THE last two numbers received of Engler's *Botanische Jahrbücher* (vol. xxx. Heft 2 and vol. xxxi. Heft 1 and 2) contain several important systematic papers—a monograph of the Diseæ (a section of Orchideæ), by R. Schlechter, and a monograph of *Mahonia*, by F. Fedde—a report on the botanical results of the Lake Nyassa and Kinga Mountain Expedition, by Prof. Engler; and a very interesting short paper by E. Ule on ant-gardens in the Amazon region. Several species of ants appear to collect the seeds of the "ant-epiphytes" and carefully bury them in humus, covering up and protecting the young plants when they germinate, and thus producing veritable gardens often of considerable size. Quite a number of these epiphytes—three Araceæ, five Bromeliaceæ, five Gesneraceæ, one Moraceæ, two Piperaceæ, one Cactaceæ—were found by Ule in these gardens and nowhere else.

THE Society for the Protection of Birds is this year offering two prizes, of 10*l.* and 5*l.* respectively, for papers on the best means of establishing a "Bird and Arbour Day" in England. In many of the schools of the United States bird days and arbour days have become a very popular institution, and have proved most successful in interesting teachers and children in birds and bird protection; and the Society's offer will, it is hoped, elicit practical hints as to the way in which the scheme may be introduced and worked in English schools. Papers are to be sent in not later than November 30, 1901, and all particulars may be obtained of the Hon. Secretary, Society for the Protection of Birds, 3, Hanover-square, London, W.

DR. T. E. THORPE's report upon the work of the Government Laboratory has recently become available. From the large amount of work described in the report, we select a few points for mention. It appears that since the Act was passed limiting the amount of moisture in tobacco to 30 per cent., manufacturers have been using an excessive quantity of oil in roll and cake tobacco. An Act was therefore passed last year limiting the proportion of oil to 4 per cent., and a process for the estimation of the amount of oil has been devised. Liquorice, glycerine, and salicylic acid are other substances found in adulterated samples of tobacco. Two samples of British-grown tobacco were received at the Government Laboratory from two small lots of tobacco which had been grown in England by persons who had not received the permission from the Board of Inland Revenue to grow tobacco—such permission is necessary even for experimental cultivation. A sample of pemmican was examined for the Committee of the National Antarctic Expedition. It was supposed to be quite free from moisture and to contain 60 per cent. of ox lard with a highly nutritive base, but on examination it was found to contain 8 per cent. of moisture and 38 per cent. of starch, whilst the total amount of fat present was only 19·6 per cent. Many other instances of adulterated goods and variation of quality are given by Dr. Thorpe. Thus, in ten samples of india-rubber the proportion of vulcanised rubber was found to vary between 5·7 and 44 per cent. Analyses made for the War Office showed that several samples of so-called butter were margarine; baking powders have been found to contain 67 and 75 per cent. of starch; cocoa paste has yielded 41 per cent. of water and only 23 per cent. of real cocoa; a sample of mustard contained 60 per cent. of added flour; strawberry jam 10 per cent. of other fruit, and many other jams and marmalade large proportions of glucose; oatmeal, flour and arrowroot were found of inferior quality, and so on. Among the drugs examined was a sample of effervescing phosphate of soda, which on analysis was found to contain arsenic equal to 4·62 grains of arsenious oxide per pound. The samples examined for the India Office were of the usual wide range. Gold-leaf is required to contain not less than 97 per cent. of pure gold, but in one instance a sample contained 5 per cent. of silver and only 91 per cent. of gold; type-metal is to consist of 65 parts of lead, 30 parts of antimony and 5 parts of tin, and yet in eight samples received together, the lead varied between 65 and 82 per cent., the antimony between 15 and 29 and the tin between 0·6 and 5·5 per cent.; antimony is required to contain less than 3 per cent. of impurities, but of five samples two contained 5·76 and 4·15 per cent. of impurity respectively. The functions of the Government Laboratory are evidently exercised over a wide field, and national interests are promoted by such analytical work as is carried on under Dr. Thorpe's direction.

IN *Symons's Meteorological Magazine* for September, Dr. H. R. Mill, who accompanied the Antarctic exploring vessel *Discovery* as far as Madeira, gives some details of the arrangements for taking observations. During the voyage out meteorological observations will be made every two hours, and these will be kept up subsequently to supplement those made at the land station. For the ordinary routine observations a form of Stevenson's Screen is erected in a position where a current of air will be blowing, when the vessel is under way. Rainfall observations are to be attempted by means of a marine rain-gauge and evaporator on Dr. Black's pattern. The position presented much difficulty; the method finally adopted was to place the gauge on the weather side, shifting it whenever the ship changes her tack, while the evaporator occupies a position on the lee side. The whole of the meteorological work on board is under the charge of the first officer, Lieutenant C. Royds. It is intended to make special observations in the Antarctic regions on the conditions of the upper atmosphere, and for this purpose a captive balloon and kites are provided. A Dines' pressure anemometer will be erected at the land station. The oceanographical observations to be made during the voyage will be under the charge of Lieutenant E. H. Shackleton, while Lieutenant M. Barne will take charge of the deep-sea soundings after leaving Melbourne.

A REMARKABLY simple astatic galvanometer is described by M. G. Lippmann in the *Journal de Physique* for August. It consists essentially of a fixed coil, or in practice two coils, and a needle suspended in such a way as to be capable of displacement parallel to itself. The needle is placed with its axis coinciding with that of the coils, and pointing in the plane of the magnetic meridian. It is suspended by a thread from one arm of a torsion balance. Now the earth's magnetism has no tendency to produce displacements of pure translation in a magnetised needle, and since it is these displacements which alone are observed, it follows that the earth exerts no force in opposition to that produced by the current in the coil; the apparatus is therefore perfectly astatic.

AN interesting phenomenon recently described in connection with the theory of sound forms the subject of a paper by Mr. Bergen Davis in the *Physical Review* for June. The property in question is that if a small cylinder, closed at one end and open at the other, is placed in a stationary sound-wave, it will not only arrange itself perpendicular to the wave, but will also move across it in the direction of its axis. By arranging four such cylinders on a rotating mill, like the cups on an anemometer, and placing this mill with its axis of rotation perpendicular to the wave front, it was found that on sounding the organ pipe producing the waves, the cylinders rotated with a high velocity, except when placed at the nodes. The phenomenon is readily explained as a consequence of Bernouilli's well-known relation between the pressure, density and velocity of a fluid.

MAXWELL'S theory, which attributes electric and magnetic phenomena to tensions and pressures in the medium that forms the seat of electric and magnetic energy, has long been a subject for criticism. In the *Nuovo Cimento*, 5, ii., Signor Luigi Giuganino now advances certain considerations arising from a mathematical investigation of the tensions in the interior of a fluid polarised magnetically or dielectrically. The author finds, among other results, that if the polarised body is compressible and behaves like a fluid body, and only carries induced charges, it is impossible to find a system of elastic stresses equivalent to the given polarisation. If, however, the polarised body is considered to be an imperfect fluid, either there exist an infinite number of systems of tensions and pressures equivalent to the polarisation, or no such system exists. The expression for these tensions and pressures does not, however, reduce to Maxwell's and Helmholtz's formula. Signor Giuganino further advances the view that the elastic constant of the fluid when polarised assumes different values along and perpendicular to the lines of force, and that herein lies the explanation of Kerr's phenomenon.

IN the last *Bollettino* of the Italian Seismological Society, Prof. Grablovitz describes a simple and inexpensive form of recording tide-gauge, the total cost of which he estimates at less than 7*l.* 10*s.* The movements recorded are those of a spiral spring the length of which changes with the varying amount of immersion of a cylinder suspended from it.

IN continuation of his previous reports, Mr. S. Arcidiacono describes the principal eruptive phenomena which occurred in Sicily and the adjacent islands during the year 1900 (*Boll. della Soc. Sismol. Ital.* vol. vii. 1900, pp. 82–91). After the great explosion in the central crater of Etna on July 19, 1899, and the short eruptive period which succeeded it, that volcano remained in a state of almost uninterrupted calm. Stromboli continued in its usual condition of slight activity, varied by a few stronger outbursts, especially in the early part of October. The solfataric phase of Vulcano and the absolute calm of the Salsa di Paterno underwent no change throughout the year.

A CATALOGUE of the marine invertebrata of Eastern Canada, by Dr. J. F. Whiteaves, has also been published by the Geological Survey of Canada (1901). It consists of a systematic list of all the species described from the Bay of Fundy, the Atlantic coast of Nova Scotia, the Gulf and mouth of the River St. Lawrence, as far north as the Strait of Belle Isle. The localities at which some of the species are found fossil in the Pleistocene deposits are also briefly indicated.

DR. G. A. F. MOLENGRAAFF, who was formerly State Geologist to the South African Republic, has written an excellent account of the geology of the Transvaal Colony, which has been published by the Geological Society of France (*Bulletin*, 4e serie, vol. i. 1901). It is accompanied by a colour-printed map, and many pictorial views and sections.

A SIXTH edition of Mr. Whitaker's useful "Guide to the Geology of London" has just been issued by the Geological Survey. The first edition was published in 1875, and in the present edition the work has grown to the extent of thirty pages, partly owing to an increased number of illustrations, including fossils, flint-implements, and sections of strata. The work has been brought thoroughly up to date, and the price remains one shilling.

WE have received from the Geological Survey of Canada the Annual Report for the year 1898 (Ottawa, 1901). This includes the Summary Report, and also a report on the mineral statistics, previously noticed in NATURE (June 15 and September 20, 1899). There are also reports on the shores of Lake Winnipeg, on those of Hudson Strait, and on Quebec province. In these the fossils of the Cambro-Silurian or Ordovician rocks of Manitoba and of Quebec receive especial attention, and there are full descriptions of the glacial phenomena. There is a good view showing the character of the surface of the Archæan rocks in Keewatin, and many other photographic illustrations of scenery and geological structure.

MR. J. J. WILKINSON has forwarded us a copy of a pamphlet giving an account of the very large and remarkable pharynx of the fly-larvæ commonly known as rat-tailed maggots, which are sometimes seen so abundantly in water. The pamphlet, which is illustrated with two plates, is published by Messrs. R. Clay and Sons, Ltd.

THE *American Naturalist* for September contains only two original communications—the one a continuation of Prof. W. M. Wheeler's account of the compound and mixed nests of American ants, and the other of Prof. H. S. Jennings' synopsis of North American invertebrates. The particular description of social ant-life treated of in Prof. Wheeler's article is that commonly known as slavery, and technically as "dulosis." Instead of slaves, it is suggested that a better title for the subservient ants would be helpmates, or auxiliaries, for the members of the two species found in the same nests behave towards each other as if they were brothers and sisters, and share the task of constructing the habitation. Unlike that which obtains in other kinds of ant-association, the so-called slaves always belong to the same subfamily group as their masters.

IN their Report for 1900 the trustees of the South African Museum remark that "the public events of the past year have, naturally, affected the Museum in more ways than one. Both the number of contributions to the collection and the number of visitors to inspect them have fallen off to a considerable extent. This is the first break in a continuous increase prolonged over a lengthened period." In spite of these discouraging circumstances, it is nevertheless hoped that substantial progress has been made both in regard to the development of the Museum and the extension of our knowledge of the South African fauna. During the year in question were issued Mr. W. L. Sclater's two volumes on the mammals of South Africa and the late Dr. Stark's volume on the birds, all of which have been noticed in our columns. The Director announces that, with the aid of the MS. left by Dr. Stark, he has completed the second volume on the birds, while the third is in hand. The Museum has been enriched by specimens of several mammals from Mr. Rhodes's park at Groote Schuur.

AN interesting and well-illustrated account of the growth and present condition of the Millport Marine Biological Station, or, as it is now called, the Marine Biological Association of the West of Scotland, appears in *Good Words* for September. As many of our readers are aware, this admirable institution, which is so largely indebted for its progress to Sir John Murray and had very small beginnings, was started to commemorate the life-work of David Robertson, the "naturalist of Cumbrae." And it is satisfactory to learn that the "Robertson Museum," occupying the upper part of the main building of the station, attracts during the season a large number of visitors, many of whom display much interest in the living creatures from the Firth of Clyde exhibited in special tanks. From its humble beginnings in the well-remembered "Ark"—a barge given by Sir J. Murray—the author traces the gradual progress of the station, which has been recently enriched by the gift, from an anonymous donor, of a deep-sea dredging steamer, and likewise by a five-year endowment from the same generous hand. As an instance of the manner in which commerce is benefited by undertakings of this nature, Mr. Sinclair tells us how the discovery of large deep-water shrimps in the Scotch lochs led to their detection in the still deeper fjords of Norway, with the result that the Norwegians now do a flourishing trade in these deep-sea crustaceans.

IN a very interesting memoir which has recently appeared in the *Proceedings* of the American Academy of Arts and Sciences (vol. xxxvi. No. 20, March 1901) Messrs. T. W. Richards and E. H. Archibald give a preliminary account of the series of investigations they are carrying on in the chemical laboratory of Harvard College on the growth of crystals. Ever since the discovery of the microscope, the gradual growth of crystals in a solution has proved a fascinating study, but the sudden way in which the embryo crystals flash into existence and the insensible manner in which they enlarge their dimensions appear to defy the acutest observer. Vogelsang introduced the method of retarding the action of the crystallising forces by adding viscous materials to the solvent, and his study of globulites and other forms of embryo crystals has been the starting-point of many important physical investigations by O. Meyer, Ostwald and others. The two American investigators, with the aid of a grant from the Rumford Fund, are now applying the method of instantaneous photomicrography to the study of growing crystals. In their first memoir they discuss the methods of procedure and give illustrations of some of their results, which appear to be full of promise.

ANTHROPOLOGISTS and folklorists would find it worth their while regularly to look over the pages of *Globus*, as in that well-edited journal there are constantly interesting and often illustrated articles and notes which are of permanent value. For example, in No. 23, Bd. lxxix., there is an essay by Julius von Negerlein on souls as birds, and a well-illustrated article on West African masks and the ceremonies with which they are associated, by Dr. Karutz. R. Palleske gives an illustrated account of a find at Ingelstad, in Sweden, of a horse's skull in which is embedded a very fine stone axe head of a form characteristic of the later half of the (Neolithic) Swedish Stone age; as it is highly probable that the horse did not exist in its wild state in Sweden after the Quaternary period, the conclusion is arrived at that in the late Neolithic age the horse was domesticated in Sweden. The original account of this interesting find was published by Gunnar Andersson, in *Ymer*, 1901, heft i. In No. 1, Bd. lxxx., F. von Luschan gives an illustrated description of a new kind of masks from New Britain, Dr. A. Krämer discusses phallic and other sacred stones from the Pacific and Dr. L. Rütimeyer figures two "stone idols" from West Africa. In No. 7 Dr. R. Lasch publishes a learned study on the fate of the souls of women who die in child-bed. All over the world there are beliefs of the disastrous results of this calamity; thus in the Malay Peninsula "the Pontianak" (or Mati-anak, as W. W. Skeat also calls it in his "Malay Magic," which book the author appears to have overlooked) "is supposed to be the ghost of a woman dying in child-bed, and is commonly seen in the form of a huge bird uttering a discordant cry. It haunts forests and burial grounds, appears to men at midnight, and it is said to emasculate them."

THE *Transactions* of the American Microscopical Society for 1900 (issued May, 1901), contains papers on a great variety of subjects, ranging from the surface impurities affecting water-supply and "limnology" (the study of lakes), to the classification of desmids and microscopic crustaceans, the parasites of the human ear and of lacustrine fish, and the description of a new cave salamander from Missouri. The latter, it may be observed, is another member of the already large American genus Spelerpes. A special feature of the volume is the first report of the newly constituted Limnological Commission, whose aim is to institute an exhaustive biological and physical investigation of the American lakes, on the plan already carried out with such success in Switzerland.

THE third instalment of Messrs. W. and G. S. West's "Alga-Flora of Yorkshire," reprinted from the *Transactions* of the Yorkshire Naturalists' Union, completes their list of the Conjugatæ (Desmidieæ) of the county, and enumerates the Siphoneæ, Protococcoideæ, and Cyanophyceæ (Myxophyceæ), with the commencement of the diatoms (Bacillariaceæ).

WE have received from Mr. J. H. Maiden, Government Botanist and Director of Botanic Garden, Sydney, copies of about thirty papers contributed by him during the years 1896–1901 to the *Agricultural Gazette* of New South Wales, and reprinted by the Department of Agriculture for the Colony, all relating to some point of interest or importance to farmers, gardeners, or fruit growers in the Colony.

IF sufficient support can be obtained, it is proposed to establish a new monthly journal, under the title *British Botanical Journal*, to afford a ready means of communication and discussion among British botanists. The contents will consist of articles and reviews, short paragraphs on important and striking current botanical matters, correspondence, short notices of books, original papers and notes, &c. Communications should be addressed to Mr. A. G. Tansley, University College, London, W.C., who will be the first editor.

Bulletin No. 28 of the U. S. Department of Agriculture, Division of Vegetable Physiology and Pathology, consists of an elaborate account, occupying more than 150 pages, of the cultural characters of the yellow flagellate bacteria *Pseudomonas Hyacinthi*, *P. campestris*, *P. Phaseoli*, and *P. Stewarti*, parasitic respectively on the hyacinth, on cruciferous plants, on leguminous plants, and on grasses, especially on maize. The favourable and unfavourable conditions for the growth of the parasites are treated of in great detail.

THE first part of a "Handbuch der vergleichenden und experimentellen Entwickelungslehre der Wirbeltiere," edited by Dr. Oscar Hertwig, has been received from the house of Gustav Fischer, Jena. The work promises to contain an exhaustive treatment of comparative and experimental embryology, and will be completed in about twenty parts at four-and-a-half marks each.

MM. GAUTHIER-VILLARS have commenced the publication of a complete "Cours d'Électricité," by Prof. H. Pellat. The work will be issued in three parts, the first of which, dealing with electrostatics, Ohm's law and thermoelectricity, has been received. The second volume will be concerned with electrodynamics, magnetism and induction, and the third with electrolysis, electro-capillarity and related questions. The part already received contains the course of work in electricity at the Sorbonne in 1898–1899; the second part will contain that carried on in 1899–1900, and the third will correspond to the course to be followed next year.

A NEW edition of "The Evolution of Sex," by Profs. Patrick Geddes and J. Arthur Thomson, reviewed in NATURE in 1890 (vol. xli. p. 51), has been published by Mr. Walter Scott. "In this revised edition," say the authors, "though many alterations and additions have been made, the original character of the work has been retained, and that notwithstanding the difficulty that the authors have in the past ten years been diverging biologically—the one towards a Neo-Lamarckian position, the other towards a Neo-Darwinian one. Yet they remain agreed on the main endeavour of the book, which is to set forth the fundamental unity underlying the Protean phenomena of sex and reproduction."

A NEW scientific periodical, the *Allgemeine Naturforscher-Zeitung*, edited by Dr. C. Wenck, commenced its career on October 2, and will appear twice weekly. The aim of the Editor is to publish scientific papers very shortly after they have been presented at meetings or congresses, and to make the journal reflect the chief characteristics of current scientific work. The first number contains two papers—one on anabiosis and the other on electrons—read at the recent Congress of Naturalists and Physicians at Hamburg, and a number of abstracts and reviews. In general character, the new periodical does not differ much from the old-established *Naturwissenschaftliche Wochenschrift*, which has just commenced a new series under the editorship of Prof. Potonié and Dr. F. Körber, and is now published by Mr. Gustav Fischer.

THE additions to the Zoological Society's Gardens during the past week include a Ring-tailed Lemur (*Lemur catta*) from Madagascar, presented by Mr. Chas. Rawsthorne; two Jays (*Garrulus glandarius*), British, presented by Mr. W. Radcliffe Saunders; three Common Snakes (*Tropidonotus natrix*), British; a Viperine Snake (*Tropidonotus viperinus*), European, presented by the Rev. H. A. Soames; a King Crab (*Limulus polyphemus*) from the North Atlantic Ocean, presented by Mr. Walker; two Arabian Baboons (*Cynocephalus hamadryas*, ♂ ♀) from Arabia, a Nilgiri Thar (*Hemitragus hylocrius*, ♂) from Southern India, four Getulian Ground Squirrels (*Xerus getulus*) from Morocco, four Great Wallaroos (*Macropus robustus*) from South Australia, an African Civet Cat (*Viverra civetta*) from South Africa, two Malayan Wrinkled Hornbills (*Rhytidoceros undulatus*) from Malacca, six Gigantic Salamanders (*Megalobatrachus maximus*) from Japan, four American Box Tortoises (*Cistudo carolina*) from North America, six Ceylonese Terrapins (*Nicoria trijuga*), nine Starred Tortoises (*Testudo elegans*) from India, a Lesueur's Water Lizard (*Physignathus lesueuri*) from Queensland, a Bearded Lizard (*Amphibolurus barbatus*) from Australia, deposited; a Rufous-necked Wallaby (*Macropus ruficollis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

DIAMETER OF VENUS.—In the *Astronomical Journal* (vol. xxii. pp. 13–15), Mr. D. A. Drew gives the results of a series of measures of the diameter of Venus, made with the 24-inch refractor of the Lowell Observatory at Flagstaff, Arizona, in 1898. For the majority of the determinations a power of 165 was employed, together with an ocular diaphragm half a millimetre in diameter and an amber-coloured glass screen.

The tabulation and discussion of the reduced diameters indicates that there appears to be a peculiar variation in the planet's diameter, decidedly periodic, which may be due partly to the variable irradiation with the different phases and brilliancy of the body at different times.

SPECTRUM AND APPEARANCE OF NOVA PERSEI.—Herr E. von Gothard announces in *Astronomische Nachrichten* (Bd. 156, No. 3738) that he has photographed the spectrum of the Nova with a 10½-inch reflector and objective prism, the result showing many of the characteristics of the peculiar structure seen in the spectra of planetary nebulæ. Bright lines are present at λλ 5007, 4861 (H_β), 4341 (H_γ), 4101 (H_δ), 3970 (H_ϵ), 3867, and a new line about λ 342. The brightest line in the whole spectrum is that at λ 3867, which is very prominent in planetary nebulæ.

He also alludes to the possibility of the aureole shown surrounding the star on photographs obtained with refracting telescopes being produced by the non-achromatic correction of these glasses for the extreme ultra-violet rays, which are so strongly developed in the Nova spectrum as to produce the chief part of the photographic action. This view of the question is also mentioned by Prof. Max Wolf in No. 3736; in

No. 3737 Skostinsky gives observations made at Pulkowa on the aureole and spectrum. The lines given are as follows:—

	λ		Intensity
1901 August 2	5010	Fairly bright line ...	10
	4960	Weak	2–3
	4861	Hβ	5
	4703	Bright, very broad...	6

ELEMENTS OF COMET 1901 I.—Mr. C. J. Merfield publishes the computed elements of the orbit of this comet in *Astronomische Nachrichten* (Bd. 156, No. 3738). The reductions are from observations made by Mr. J. Tebbutt on 1901 May 3, 11 and 19.

$$T = 1901 \text{ April } 24{\cdot}22532 \text{ G.M.T.}$$

$$\left.\begin{array}{l} \omega = 202^\circ\ 48'\ 46'' \\ \Omega = 109\ 46\ 23 \\ i = 131\ \ 2\ 35 \end{array}\right\} 1901{\cdot}0$$

$$\log q = 9{\cdot}3873832$$
$$\log e = 9{\cdot}9983750$$

THE GLASGOW MEETING OF THE BRITISH ASSOCIATION.

SECTION K.

BOTANY.

OPENING ADDRESS BY PROF. I. BAYLEY BALFOUR, LL.D. (GLASG.), F.R.S., PRESIDENT OF THE SECTION.

I SHOULD be wanting in my duty, alike to you and to our science, were I at the outset of our proceedings to pass over without notice the circumstances of environment in which we assemble to-day. In this, the first year of the century, our Section meets for the first time in Scotland, and finds itself housed in this magnificent Botanical Institute, which, through the energy and devotion of Prof. Bower, has been added this year to the equipment of Botany in this country. A few months ago the Institute was opened in the happiest auspices and with all the distinction that the presence of our veteran botanist, Sir Joseph Hooker, supported by two other ex-Presidents of the Royal Society—Lord Lister and Lord Kelvin—could give to the ceremony. I am sure we will cordially echo the words of goodwill that were spoken on that occasion. It must be to all of us a matter of congratulation that Botany has now provided for it in Glasgow this Institute both for its teaching and for the investigation of its inner secrets, and we may with confidence hope that the output of valuable additions to our knowledge of plant-life which has marked Glasgow during the tenure of office of its present distinguished Professor of Botany, and in which he himself has borne so large a share, will not only continue but will increase in a ratio not incommensurate with the facilities that are now provided.

The subject of my address is the group of Angiosperms. I will speak generally of some points in their construction from the point of view of their position as the dominant vegetation of the earth's surface at the present time, and more particularly of their relationship to water, as it is one which has much to do with their holding the position they now have. I wish, however, in the first place to refer to

The Communal Organisation of Angiosperms.

No fact of the construction of the plant-body that has been established within recent years is of greater importance than that of the continuity of protoplasm in pluricellular plants. As has been the case with so many epoch-making discoveries, we owe our first knowledge of this to the work of a British botanist. The demonstration by Gardiner of the existence of intercellular protoplasmic connections is the foundation of our modern notion of the constitution of the pluricellular plant-body and of the far-reaching conception of the communal organisation of Angiosperms and of all other Metaphyta.[1] It has settled, once and for all, phytomeric hypotheses. We now realise that in an Angiosperm the living plurinucleated protoplasm is spread over a skeletal support furnished by the cell-chambers of shoot and root. The energid of each living cell is connected with the adjacent energids by the protoplasmic threads piercing the separating cell-membrane. The protoplasm thus forms a continuous whole in the plant. According to their position in the organism the energids become devoted to the formation of special tissues for the building up of the various organs. Each one of them, however, whilst its actual destiny is ultimately determined by its relationships to the others, is, so long as its fate as a permanent element is not fixed, a potential protophyte, that is to say, it has within it all the capacities of the plant-organism to which it belongs.

Their construction out of this assemblage of protophytes—this colonial, or perhaps better communal, organisation—gives to Angiosperms their power of discarding effete and old parts of the plant-body without mutilation, of allowing these to pass out of the region of active life yet to remain without damage to the organism as part of the body, of renewing and replacing members as required. The response of the plant to the various horticultural operations of pruning, propagation by cuttings, and so forth is an outcome of this constitution. It is this which gives them the power of developing reproductive organs at any part of the plant-body, to cast them off when their work is done, and to renew them again and again. This dispersion of the reproductive capacity in the Angiosperm is one of the most striking of the properties it possesses, and is perhaps in no way better shown than in the development of stool-shoots. There the energids of the cambium, which normally produce the permanent tissue of wood and bark, and thereby add periodically to the girth of a tree, give origin when the relationships are changed by the cutting over of its bole to a callus from which stool-shoots arise as new growths, which may ultimately produce flower and reproductive organs.

Another outcome of this organisation of the Angiosperm is its power of extension and its longevity. It is potentially immortal. How far this expectation of life of a plant is realised in nature we have no evidence to show. Possibly we may presage the longest life in the case of perennial herbs. Trees and shrubs by their exposure in the air are liable to injury which must militate against long life, and yet cases of trees of great age are well known to you all.

It is this feature of the life of Angiosperms which marks them out sharply in contrast with the higher members of the animal kingdom. There we have individuality, and consequently comparatively short life. Let me emphasise this.

Of the Vegetable Kingdom and the Animal Kingdom.

The root-difference between plants and animals is one of nutrition. Plants are autotrophic, animals heterotrophic.

Whatever has been the origin of the two kingdoms, we must trace the differentiation of plants to their acquisition of chlorophyll as a medium for the absorption of the energy of the sun. The imprint of its operation is borne in the construction of all higher plants and distinguishes them from animals. The vegetative mechanism of the plant has been elaborated upon lines enabling it to obtain the materials of its food from gases and liquids which it absorbs from its environment. For the plant the primary requisite has been a sufficient surface of exposure in the medium whence it could obtain energy along with the gases and liquids of its food. To this end the fixed habit is an obvious advantage, for the question of bulk within the limits of nutrition becomes thereby not a matter of moment; and an upward and a downward extension gives opportunity for the creation of a larger expanse of absorptive surface. Thus it has come about that the plant-organism has developed that polarity which finds expression in the profuse root-system and shoot-system with their localised growing points of the highest forms of to-day. That the communal organisation is well fitted to this mode of life requires no exposition.

The nutritive mechanism of animals, on the other hand, has become one for the ingestion of solids which it obtains by preying upon the bodies of plants and other animals. The exigencies of its feeding have compelled the adoption by the animal of the habit of locomotion, the development of an apparatus for the capture of its prey, and of an alimentary canal for its introduction to the body, for its digestion, and for the final ejection of the unused matter along with the waste of the body. This has

[1] Metaphyta and its antonym Protophyta are well-established names for groups of polyergic and monergic plants respectively. The recent appropriation of Metaphyta as a group name for Vasculares, *i.e.* plants derived from the second antithetic generation, and of Protophyta for Cellulares, *i.e.* plants derived from the first antithetic generation, is unfortunate.

involved the concentration and the specialisation of the individual.

All this is, however, to you botanists but the commonplace of your laboratories and lecture halls. But I have thought that it should be said, because this fundamental difference of organisation between the two kingdoms is apt to be forgotten in discussions of problems of evolution, more particularly those of transmission of characters and the effect of environment. This is especially so when they are approached from the zoological side. Were the point always recognised we should not have zoologists finding similarity between bud-variation in a flowering plant and the change in colour of the hair of a mammal.

Of Origin and Dominance of the Angiospermous Type.

It is now usually admitted that all plants, like all animals, have been derived from aquatic ancestors, and that the trend of evolution has been in the direction of the establishment of a vegetation adapted to a life on land. Of this evolution the Angiosperms as we see them to-day are the highest expression. Can we say anything about the origin of the angiospermous type? As the problem presents itself to me we can only mark time at present.

From the geological record we obtain no help. The earliest traces of Angiosperms in rocks of the middle Mesozoic period enable us to say little regarding them except that the fragments give evidence of an organisation as complete as that possessed by the Angiosperms of the present day. The gap between the angiospermous and other types of vegetation is a wide one, and no links are known. Until further research provides specimens in a better state of preservation and showing structure we can hope for little assistance from the geological record; and when we consider the circumstances in which the angiospermous plants as a whole grow the prospect of such finds does not appear to be very bright.

The appeal to ontogeny likewise gives us little information. Comparative study does not establish connection with, only differentiates more and more, the types of the Pteridophytes and Gymnosperms. The strong likeness of the pro-embryo after the primary segmentation of many Angiosperms to the pro-embryo of many Bryophytes has appeared a sufficient reason to some botanists for ascribing a bryophytous parentage to the Angiosperms. Indeed it has been said that "the monocotylous embryo is the direct homologue of the sporogonium of the moss, the cotyledon being homologous with the spore-producing portion of this out of which it originated." This anaphytic conception of the monocotylous embryo seems to me to have as little real foundation as the hypothesis of its origin. The pro-embryonic resemblance is interesting, but it may as well be homoplastic as genetic.

But if the information available to us does not permit of our building up a pedigree for the Angiosperms, we are on surer ground when we endeavour to fix upon characters which have enabled the group to become established as the dominant vegetation of our epoch. Before the era at which we have first knowledge of Angiosperms the earth's surface was, we know, clad with a dense vegetation composed of members of the various classes of Pteridophytes and Gymnosperms. These appear to have existed in all the growth-forms which we know now amongst the Angiosperms—Herb, Shrub, Tree, Liane. Yet they are now represented amongst living plants by only a few remanent forms. Hordes of distinct forms and whole classes have disappeared, giving place to plants of the angiospermous type. There must then be some feature or features of advantage in this type over those of the groups that previously occupied the ground, and through which it became dominant.

In considering this point we must bear in mind the well-known climatic differences—particularly in the distribution of water—that distinguish our epoch from those in which these extinct plants throve. The factors which determine the success or otherwise of an organism or group of organisms at any period must always be complex, and no exception can be claimed for plants in their struggle for mastery. But looking at the succession of plant life in the world in relation to the known diminution of water-surface and increase of land-area, and the consequent differentiation of climates, we cannot but be convinced that of these factors water is one which has had supreme influence upon the evolution of the facies of the plant-life that we see to-day. I think the statement is warranted that the Angiosperms have become dominant in great measure because in their construction the problem of the plant's relationship to water on a land-area has been solved more satisfactorily than in the case of the groups that preceded them.

The seed character—and the flower which it involves—distinguishes the Angiosperms. What, then, are the relationships to water which the formation of seed implies and through which the Angiosperm has advantage?

Two prominent risks in its relation to water attach to the process of sexual reproduction in a plant of the type of heterosporous Pteridophytes. Firstly, that of failure of moisture on the soil sufficient to promote germination of the spores; secondly, that of failure of moisture on the soil sufficient for the passage of the spermatozoid to the ovum. In addition there is the risk of failure of the fall of microspores and megaspores together upon the soil. In the Angiosperms such risks are practically abolished in the formation of flower. The stigmatic surface of the style itself provides a secretion—the more copious in a dry and sunny atmosphere—to moisten the pollen-grain and stimulate germination, and for the spontaneous movement of the spermatozoid is substituted the passive carriage of the male gamete to the ovum by the agency of the pollen-tube. Possible failure of pollination is, too, provided against by the complex mechanism of the flower in the highest forms in relation to insect-visits. The sexual act, then, might, we conceive, gradually become more and more difficult of consummation to the Pteridophyte as the area of dry land increased. To the seed-plant it was more secure by its independence of the presence of free water. The failure of performance of the function of sexual reproduction may have hastened the disappearance of Pteridophytes before the advance of the Angiosperms.

But if this flower-mechanism relieves the Angiosperm from risks in the performance of the sexual act, it imposes a new duty upon the plant, that of nursing the embryo within the sporangium. This involves a water-supply of a kind not demanded in the Pteridophytes, and we may gain some idea of the importance of this by a comparison of the trivial vascular system required to supply through the stamen the pollen-grain, with the copious system that traverses the gynæceum for the ovules. It is, however, to the ovule—the immediate nursery of the embryo—that we must look for special indications of this water-relationship of which I speak.

Perhaps no organ has given rise to more discussion than this characteristic one of flowering plants. To most of us I believe the controversy over its axial or foliar nature will be, in a measure, historical only. All recent investigations of sporangia—and to no one does Botany owe more in this respect than to Bower—tend to confirm the view that it is, and always has been, an organ *sui generis*. To that category the nucellus of the ovule is now pretty generally admitted. It is the body of a sporangium. But the nature of the tegumentary system and of the funicle which give the ovule so distinctive a character is still the subject of disagreement.[1]

I do not share a view which sees in the integuments or other parts of the ovule anything of an axial or of a foliar nature. To me the funicle is a sporangiophore—a sporangial stalk—and the tegumentary system is an outgrowth of the sporangial primordium of somewhat variable origin and development, whose first function it is to carry and store water for the embryo, and then also to serve as a food-reservoir. The whole construction is adapted to the function claimed for it. The well-developed vascular system from the placenta traverses the funicle, but the subsequent fate of the nucellus forbids its passing through this, and the needs in respect of water (and what it carries) of the embryo and of the other further developments that proceed in the embryo-sac are provided for by the production of the tegumentary outgrowths into which the vascular system may, if necessary, be continued and spread out.

That the tegumentary covering has this function we have direct proof in its penetration by haustoria, derived either from the embryo itself or from the embryo-sac, which absorb from it water and food for the developing embryo. These haustoria appear to be much more elaborate and more widespread than has been supposed, and a definite correlation has been established in many cases between them and the integuments. The thicker the integument the better developed is the haustorium.

[1] Scott's discovery of a bracteal investment to the megasporangium in Lepidocarpon is an interesting one in relation to the question of the enclosure of sporangia. It shows how in the Lepidodendreæ a covering of the sporangium could be developed, much in the same way as a carpellary envelope in Angiosperms. Whether the ovular integument or the ovarian covering in Angiosperms was the earlier development is open to discussion. I am disposed to give precedence to the ovular coat.

In some ovules where no vascular system appears in the integument, the chalazal haustorium is prominent, and it can therefore at once tap the main water-supply of the ovule. We know also of cellular ingrowths proceeding from the vicinity of the vascular system of the raphe to the interior of the embryo-sac, and these, too, may have a conducting function. All these point to a water and nutritive function in the integuments. The protective function of the tegumentary system to which attention has been chiefly directed must be primarily only slight. It only becomes prominent as the seed is formed, and then changes consonant therewith, and with its changed function, proceed within it. Nor can we now, with our increased knowledge of the ways in which the pollen-tube may reach the embryo-sac, consider the function of the integuments in forming the micropylar canal as one of so much importance to the reproductive act as was formerly supposed. We obtain, I think, a better conception of the ovule in the view that the primary function of the tegumentary system is that of a water-jacket and food-store, and that it has been developed in response to the special demands for water involved in the seed-habit.[1]

To the question why there are two integuments in some cases and only one in others we can only reply that our knowledge of ovular structure and changes is yet too slight to permit of a definite opinion being expressed. We find that there is a remarkable concurrence of the unitegminous ovule with a gamopetalous corolla in the flower, for the character apparently holds for the whole of the gamopetalous Dicotyledones excepting Primulales. On the other hand, not all Polypetalæ have bitegminous ovules, whilst bitegmeny is usual in Monocotyledones. Recently the character has been used by Van Tieghem as one of prominence in his new classification of the families of Dicotyledones. But it is not so constant an one as his groups of Unitegmineæ and Bitegmineæ would lead one to suppose. The degree in which it is inconstant we cannot yet fix, because we know details of so few genera. We do know, however, that all genera in one family are not always alike in respect of it. In Ranunculaceæ, for instance, the most of the genera with radial flowers are unitegminous, whilst those with dorsiventral flowers are bitegminous. Again, in Rosaceæ, the Potentillæ are unitegminous, as is Rosa, whilst Pomeæ and Pruneæ are bitegminous; and of the Spiræeæ, Neillia is unitegminous, but the closely allied Spiræa is bitegminous.[2] In other cases the character confirms distinctions; as, for instance, in separating the unitegminous Betuleæ and Coryleæ from the bitegminous Quercineæ. The explanation of all these constructions may, I suggest, be sought for with better prospect of success in the water-relationship and food-relationship of the integuments to the embryo than in protective function and relations to pollination. It is, perhaps, not without significance from this point of view that in, for instance, the Gamopetalæ such protective function as attaches to the tegumentary system in the seed is reduced or extinguished through the development of indehiscent fruits, accompanied in many Aggregatæ and higher Heteromeræ by the sinking of the gynæceum in the torus, and in many Bicarpelletæ by its enclosure in a persistent accrescent calyx.

All the information at our disposal seems to indicate that the tegumentary system of the ovule is extremely adaptive, and that its characters are not of themselves of much phyletic import. An extended examination of its characters as an organ of the nature I have depicted in relation to embryogeny is greatly needed. It is made all the more interesting by the questions of development of endosperm opened by the discovery of "double fertilisation." There is no more promising field of investigation than this, for it must yield results infinitely more interesting than the technicalities of formal morphology which have been for too long the stimulus to ovular research. I am tempted to go further and to say that it might supply an explanation of that most puzzling of subjects, the forms and curvature of the ovule. The common assumption that these have relation to pollination and make the advent of the pollen-tube at the micropyle easier is not altogether satisfactory. For the curvature not infrequently seems to place the micropyle in a position the opposite of favourable, and there is an absence of curvature in cases where it would appear to be desirable.

I will not dwell upon the subject of the seed itself as an advantage to the Angiosperm. Its construction follows upon the successful water-relation previously secured. We all know how its manifold adaptations to dissemination bring about its fortuitous deposition upon various soils, and the embryo is placed well guarded within the seed-coat ready to take advantage of the moment when moisture is sufficient for its germination.

Whilst the seed-habit is the character which has primarily given to Angiosperms their advantage as a land-type,[1] their vegetative organs also show an advance in their relationship to water upon those of the forms they have supplanted. I have already remarked that the growth-forms of the vegetation of the present day are the same as those of old. That means that the early as well as the later groups of vegetation have solved in much the same way, so far as general form is concerned, the problem of the exposure in the atmosphere of a large assimilating area with a sufficient mechanical support and adequate water-supply. That wherever a water-carrying system is found in these growth-forms it dominates the anatomy is witness to the importance of the water-relationships I wish to emphasise.

There are two features in the water-carrying system of Angiosperms in which they are superior to the older types—namely, their general monostely and their vasa.

No one will contest that polystely is a less perfect mechanism for water-carriage in a massive plant than is monostely. The limitation imposed by it to an increment in the area of carriage contrasts unfavourably with the openness in this respect possessed by monostely. In the moister climatic conditions of the age of domination of Pteridophytes polystely may have well sufficed for the water-needs of the plants, especially of the dwarfer forms; but even then, as we know, monostely was the habit in many of the larger tree-forms, and the development of a cambium enabled them to provide for continued additions to their carrying system. Where such monostely and secondary growth occurred in these older types their adaptation in these respects to water-carriage was on lines similar to those of our dominant Dicotyledones and was effective in giving them dominance in their epoch. There is no more interesting page in the history of evolution than that—and we owe it in large measure to the labours of Scott and Seward—upon which is depicted the struggle of some polystelic forms amongst these old plants to achieve the structural facilities more easily attained through monostelic construction. The existence of polystely in a few Angiosperms only confirms the advantage which the whole group has derived from its monostely. Such polystelic forms amongst them as we know have many of them special water-adaptations, and in no case can they be said to be progressive types.

I do not need to remind you that vasa are not the exclusive possession of the angiospermous type, but they are the conspicuous feature of their carrying system, whilst the tracheid is the leading one in the older type of vegetation. All anatomical evidence indicates that vasa give greater facility to rapid transport of water than do other elements, and we may, therefore, conclude that they have been adjuvants in enabling the Angiosperm to meet effectively the demand made upon it by the drier atmospheric conditions.

I now pass on to consider from the same standpoint the classes which make up the group of Angiosperms.

Of the Classes of Angiosperms.

There has been for long a general recognition of two classes amongst the Angiosperms—Dicotyledones and Monocotyledones—separated one from the other by definite characters which I need not specially depict here. Recently, however, we have seen an attempt made by Van Tieghem to establish another class—that of Liorhizal Dicotyledones—for which is claimed a rank equal to that of the Dicotyledones and Monocotyledones. Were this valid it would be a matter of supreme importance, for whatever be the relationship between Dicotyledones and Monocotyledones there can be no doubt of their having developed as

[1] To discuss the morphological interpretations of the funicle and integument that have been advanced would carry me beyond the scope of this address. I do not know that an axial hypothesis for any part of the ovule is now maintained. The foliar interpretation of the funicle and integuments as against their sporangial nature is supported by two distinct schools of botanists. One approaches the subject from the standpoint of the anaphytose of the earlier years of last century, and appeals largely to teratology; the other from that of vascular anatomy. I do not accept the starting-point of either the one or the other.

[2] Spiræa is, however, exalbuminous, whilst Neillia is albuminous.

[1] Gymnosperms, sharing with Angiosperms the seed-habit, have in that had advantage over Pteridophytes. But their flower-mechanism is much less perfect. The reasons for their being bested as a class by Angiosperms must be complex. Gymnosperms, as a whole as we know them, are less adaptive than Angiosperms. The decadence of the cycadean line of descent may have been helped by their conservatism in the methods of water-carriage in the vegetative organs. The coniferous type has held its own in the Northern Hemisphere.

distinct groups within the whole period of which we have knowledge of them, and the existence of a third class intermediate or outside of them might lead to interesting conclusions. It is worth while, therefore, to consider the evidence on which this class is founded. It includes two of our recognised families —the Nymphæaceæ and the Gramineæ.

What is the exact position and the affinities of the Nymphæaceæ amongst Angiosperms is no new theme of discussion. That they have characters resembling those of Monocotyledones[1] has often been insisted on. Van Tieghem lays stress on what he considers the monocotylous differentiation of the root-apex and the derivation of the piliferous layer from the same meristem-initials as the cortex, whilst in the embryo he finds the two cotyledons of Dicotyledones. But the most recent observations of the embryogeny of the family go to show that the embryo is that of the monocotylous plants, the apparent dicotylous character being the result of the splitting of one cotyledon. If this be so the position of Nymphæaceæ will be amongst the Monocotyledones, a position the root-characters in Van Tieghem's view will support. But whether this be confirmed by further research or no—and a complete reinvestigation of their embryogeny and development is much wanted—what we may say at present is that it is not in features such as this one of the root-apex—which is, after all, not so simple and uniform as Van Tieghem would have it—that we are likely to find phyletic diagnostic characters of groups.

The reason for the inclusion of the Gramineæ in this new group is the assumed presence of a second cotyledon. The construction of the embryo of grasses is peculiar, as is well-known, and has for a long time been a main support of the hypothesis that the Monocotyledones are derived from the Dicotyledones; for here alone, since the dicotylous character of forms like the Dioscoreæ was shown to be untenable, was there a structure which could be interpreted as evidence of a reduced second cotyledon. The idea that the epiblast is such a structure was enunciated by Poiteau at the beginning of the last century, and along with hypotheses of the nature of the other parts of the grass-embryo has been a subject of vigorous discussion since that time. The controversy is not yet closed. Whilst we have Van Tieghem now adopting the view of the cotylar nature of the epiblast and using it as a character of fundamental taxonomic importance, we have others who as strongly uphold the interpretation of it, first formulated by Gaertner, as a winged appendage of the scutellum, which is considered to be the cotylar lamella. And, again, there are those who take the view that it is a mere outgrowth of the hypocotylar body of the embryo and without any cotylar homology. Our interpretation of the part must depend primarily upon the standpoint from which we view the embryo of Angiosperms. This I shall discuss presently. All I need say here, *àpropos* of the class of Liorhizal Dicotyledones, is that whatever the epiblast be—and for my part I am disposed to regard this simple cellular structure as merely an outgrowth with a water-function from the embryonal corm—a dispassionate consideration must lead us to hold that it is a bold step to use a character the morphological value of which can be so variously interpreted as one of primary importance for separation of a group of Angiosperms. Moreover, we must remember that the feature of the epiblast is not one of universal occurrence in the Gramineæ. If we take a well-defined tribe like the Hordeæ, as framed by Bentham and Hooker, we find that of eight of its twelve genera which have been examined for this feature five have the epiblast and three want it. And surely the fact of its presence in Triticum and absence in Secale, its presence in Elymus and absence in Hordeum, is strong evidence that the epiblast is not a character of such importance as it would have were it a reduced cotyledon as is asserted.

It appears to me, therefore, that this third class of Angiosperms has no sound foundation, no more, perhaps less, than Dictyogens and Rhizogens which appeared as parallel groups with Endogens and Exogens in Lindley's old classification. Our present knowledge allows the recognition of only two classes of the angiospermous type—the Dicotyledones and the Monocotyledones.

Of Dicotyledones and Monocotyledones.

The relationship of these two groups is involved in the origin of the angiospermous type. They may have had a common origin or they may have arisen separately; and if the former the Dicotyledones may have been a subsequent offshoot from the Monocotyledones, or the reverse may have been the case. Each of these possibilities has its supporters. Were I to maintain an opinion it would be that the two classes have arisen on separate lines of descent. The embryo-characters, as well as those of the epicotyl, can, I think, be shown to be fundamentally different and to afford no basis for an assumed phyletic connection. The differences between Hepaticæ and Musci, to take a parallel case in a lower grade, are not more conspicuous. The parallel sequence in development in the two classes is no more than one would expect, and may be regarded as homoplastic. To the question which group is the older I would answer that the Dicotyledones are by far the most adaptive and progressive if—as is not necessarily the case—this can be taken as evidence of their more recent origin. This, however, is not the matter I intend to discuss here. I wish rather to inquire if there are any features broadly characterising the groups to which, as in the case of Angiosperms as a whole, we may look for help to an explanation of the predominance at this time of the type of Dicotyledones. I think there are, but they are not to be found in the reproductive system. That is constructed on sufficiently similar lines in each class. The features I refer to are to be found in the construction of the vegetative system both in the embryo and in the adult. That of the former gives the dicotylous plant an advantage in its start on life; that of the latter, both in shoot-system and root-system, is better adapted in Dicotyledones in relation to water-supply.

I specially differentiate the embryo-condition from the adult because in our consideration of these higher plants we are apt to overlook the two distinct stages into which their life is divided, and which call for altogether different adaptations. There is, firstly, the life in the seed and in germination; and, secondly, there is the life after germination. The conditions and the manner of life are not alike in the two stages. In the first the plant is heterotrophic, in the second it is autotrophic. The functions of the portion of the plant which lives the life within the seed, and which bears the incipient epicotyl and primary root as small, at times hardly developed, parts, are to absorb food, either before germination, as in exalbuminous seeds, or during germination in albuminous seeds, to rupture the seed-coat, and to place the plumular bud and the primary root in a satisfactory position for their growth and subsequent elongation. The functions of the adult may be summarised as the development and maintenance of a large assimilating and absorbing area preparatory to reproduction.

We ought, I think, to look upon the embryo as a protocorm[1] of embryonic tissue adapted to a seed-life. Under the influence of its heterotrophic nutrition and seed-environment it may develop organs not represented in the adult plant as we see in, for instance, the embryonal intraovular and extra-ovular haustoria it often possesses. There is no reason to assume that there must be homologies between the protocorm and the adult outside an axial part with its polarity. There may be homologous organs. But neither in ontogeny nor in phylogeny is there sufficient evidence to show that the parts of the embryo are a reduction of those of the adult.[2]

The protocorm has, I believe, developed along different lines in the Dicotyledones and Monocotyledones. This has been to the advantage of the former in the provision that has been made for rapid as opposed to sluggish further development. Confining ourselves to the general case, the axial portion of the protocorm of the Dicotyledon, the hypocotyl, bears a pair of lateral outgrowths, the cotyledons, and terminates in the plumular bud and in the primary root respectively. The cotyledons are its suctorial organs, and the hypocotyl does the work of rupturing the seed and placing the plumular bud and root by a rapid

[1] The anatomical characters upon which this resemblance was chiefly based are now known to be of another nature.

[1] The term has already been used for the embryo of Orchideæ, where the axis is tuberous as is the structure to which the term has been given in Lycopodineæ. But tuberousness is not an essential for the designation corm.

[2] I cannot pursue the subject here, nor discuss the view of the cotyledons as either ancestral leaf-forms or arrested epicotylar leaves. The analogies with existing Pteridophytes that are cited are not pertinent, for there is no evidence that Angiosperms have that ancestry, or indeed that their phylogeny was through forms with free embryos. Nor is the fact of resemblance between cotyledons and epicotylar leaves and the existence of transitions between them convincing. That the cotyledons, primarily suctorial organs, should change their function and become leaf-like under the new conditions after germination is no more peculiar than that the hypocotyl should take the form of an epicotylar internode, from which it is intrinsically different as the frequent development upon it of hypocotylar buds throughout its extent shows.

elongation[1] which commonly brings the plumular bud above ground, protected, it may be, by the cotyledons. These latter may then become the first assimilating organs unlike or like to the epicotylar leaves. In the Monocotyledones the axial portion of the protocorm has usually no suctorial outgrowths. Its apex and usually its base also are of limited growth. The plumular bud is a lateral development, and the primary root often an internal one. The suctorial function is performed by the apex of the protocorm, termed here also the cotyledon.[2] The rupture of the seed and the placing of the plumule along with the primary root—for the axis of the corm does not elongate between them—are the work of the base of the suctorial portion of the corm.

The whole arrangement in Monocotyledones is in marked contrast with that of the Dicotyledones. Instead of the free axial elongation begun in the protocorm and continued upwards and downwards in the epicotyl and primary root, there is limited axial growth of the protocorm with lateral outgrowth of the plumular bud and arrest of the primary root. These differences in the protocorm are, I think, primary, and they point to independent origins of the two groups. The advantage lies, as I have said, with the Dicotyledones, and we find that the features of development of the protocorm are continued in the adult. There is a marked contrast between the free internodal growth of the shoots of Dicotyledones with their copious root-system and the contracted stem-growth and the arrested root-system in Monocotyledones. It is interesting to note further how the monocotylous type has developed so largely upon restricted lines in the way of short rhizomatous, often tuberous, growth, whilst the dicotylous gives us the characteristic growth-form tree.

When we compare the tree-type of the Dicotyledones with that of the Monocotyledones we see at once the feature I refer to in the adult, which has given the advantage to the dicotylous type in respect of its water-supply. In Dicotyledones we have a much-branched stem ending with numerous shoots with long internodes and small apices, and bearing many small leaves which are mainly deciduous. In the monocotylous tree, of which we may take the palm as a type, there is a straight stem with short internodes, a large apex bearing few large leaves not often renewed; if there be branching it takes more or less the form of a fork. The whole of this external configuration bears relationship to the internal structure. In the Dicotyledon the open bundles of the central vascular system provide through their cambium for a continued increase of the water-carrying system and medullary rays, which, although it is to many a heresy, I hold to have profound influence upon the movement of water in trees. The buttressing of the branches is also secured, and thus is rendered possible a large assimilating area made up of a vast number of small individual surfaces, each one of which can be readily thrown off. In the Monocotyledones, on the other hand, the distribution of a large number of closed vascular bundles in a matrix without a cambium involves the provision of a broad terminal cone, gives no support, outside interstitial growth, to lateral branches, which are consequently when developed placed so as to give an equipose, and the assimilating surface has to be concentrated in a few large leaves. The possession of cambium has enabled the Dicotyledones to meet in a much better way the requirements of water-supply and strength in correlation with feeding.

The general uniformity and effectiveness of the scheme of cambial growth is a remarkable feature in the dicotylous type; but there is still a wide field of investigation in the relationships of size and distribution of vasa both to the other structural elements of the stem and to the form of the plant in relation to its environment. So far as I know the monocotylous tree-forms, there has been an attempt in two different directions to provide an increased water-carrying system in them. There is the familiar one of the secondary cortical cambium in Dracæna and other genera. In them the cambium merely repeats in its products the construction of the primary stem, and does not provide so copious an increase of carrying area as does the system in dicotylous plants. And then in such plants as Barbacenia, many Bromeliaceæ, perhaps Kingia, we have an arrangement reminiscent of the superficial root-system which is found in many polystelic arborescent Pteridophytes of the present day. There is a copious growth of adventitious roots from the central vascular cylinder, and these pass down within the cortex, and from its cells are no doubt able to draw water for the upper parts of the stem.[1] Ultimately many of these roots reach the soil. At best, however, neither of these systems has been satisfactory. All that can be said for them is that they have enabled the monocotylous trees in which they are found to hold their own in xerophilous conditions.

Of Phyla within Dicotyledones and Monocotyledones.

A brief reference only to the groups within the Dicotyledones and Monocotyledones must conclude these remarks. Whilst there is a wonderful concurrence in the opinion of botanists as to the natural groups—real phyla, whether termed cohorts, alliances, or series—into which many of the families of both Dicotyledones and Monocotyledones fall, there is irreconcilable divergence of view as to their genetic sequence or sequences. And this is not surprising when we remember that we know nothing of the starting point or points of the classes themselves; and have, moreover, no critical mark by which to diagnose a primitive from a reduced feature in many of the flower constructions to which, as characteristic of Angiosperms, importance is attached. The desire to establish a monophyletic sequence of these phyla is natural, and finds expression in pedigrees of Dicotyledones issuing from, it may be, Ranales or Piperales, of Monocotyledones from, say, Apocarpæ or Arales. But all such attempts appear to me, in the present state of our knowledge, to be in vain. We see in the phyla, as we know them, culminating series in our epoch in lines of descent; some, for instance Myrtales or Lamiales, progressive; others, like Primulales or Pandales, apparently not so. We also recognise that these series group themselves in many cases as branches of broader lines of descent; for example, in the Bicarpellatæ of Gamopetalæ, in the Helobieæ of Monocotyledones. To a greater or less degree such relationships are traceable now, and as we obtain more knowledge of the angiospermous plant-life of the world they will be widened. But this is a different thing from the carrying back the pedigree of every phylum of dicotylous and monocotylous plants to one or other of the existing ones, which may possess what are taken to be elementary characters. We have, so far as I know, no evidence to sanction the belief, or even the expectation, that there is extant any family of Dicotyledones or Monocotyledones which represents, even approximately, a primitive type in either class. The stem in each has gone. We have the twigs upon a few broken branches.

Amongst the phyla we cannot discern any one type that can be described as the dominant one. The multifarious adaptability of the angiospermous type has given us diverse forms, suited, as far as we discern, no less well to the varied environments of our epoch. Yet we are able to differentiate certain of them which take precedence alike in point of number of species and in area of distribution. If we seek for some general character that marks these advanced groups we find it in the tendency to greater investiture of the ovule, both in Dicotyledones and Monocotyledones. This is brought about in different ways; for instance, by the sinking of the gynæceum in the torus as in Compositæ, by inclusion within a persistent calyx as in Labiatæ, or within bracts as in Gramineæ. This feature, it will be observed, emphasises that which I have put in the forefront, as leading to the establishment of the angiospermous type. That it must give greater security to the embryo in relation to its water supply is obvious, although it has evidently also direct

[1] In relation to this function it is noteworthy that the hypocotyl relatively seldom in the exalbuminous seed of Dicotyledones becomes the reservoir of food-material, whereas in Monocotyledones the axis of the embryo is the usual seat of deposition.

[2] I use the term purely as an objective designation, and in the original meaning of the suctorial organ in the embryo. This terminal cotyledon in the Monocotyledones is not a leaf nor the homologue of the lateral cotyledones in the Dicotyledones. The "traceable and direct developmental history in the formation" of the two organs is clear, and they are not alike. To those who hold the contrary view a terminal leaf is no obstacle. I think, however, the question of lateral or terminal is of importance in organography. The "sympodial leaf-from-leaf evolution," described in the first epicotylar stages of Juncus, Pistia, and other plants, demands examination with the aid of modern methods. All cases of vegetative organs in which the distinctions between organs are said to break down are worthy of being looked at in the light of their relation to their nutritive environment. How nutrition affects plant-form we do not yet understand. Its effects are familiar, both in vegetative and reproductive organs. The grosser cases, in parasites, show in the extremes an abolition of most of the landmarks of morphology—"the whole scheme of formation of organs is jumbled." Heterotrophic "jumbles" do not, however, deny the ordinary morphological categories. Pseudo-terminal reproductive organs are to be expected under the cessation of growth with which their development is concurrent.

[1] I leave it to Palæophytologists to say whether this construction may sometimes account for the profusion of roots alongside of stem-structure in fossil-sections.

connection with seed-dispersal. Another general character observed in these higher groups is the greater security for economical pollination afforded by the adaptations in relation to insect-visits. At the same time the case of the Gramineæ shows us that other adaptations in this respect are not incompatible with prominence.

I will not dwell upon the influence of water upon the vegetative organs in Dicotyledones and Monocotyledones. Of all the factors of environment its effects are best known because most easily seen. The examination of plants from the standpoint of their relation to water—bearing in mind that this is physiological, and not merely physical—has already thrown a flood of light upon their forms and upon their distribution, and offers a fertile field of investigation for the future.

Water has been, then, a dominating influence at all periods in the evolution of our vegetation. The picture of its claim in this respect which I have presented to you is drawn in the broadest outline, and with the intention more of recalling points of view from which familiar facts in the life of plants may be looked at. It is just occasions like this which give the opportunity of telling to a competent audience of the impressions received by one's most recent glimpse in the kaleidoscope of plant-life. It is in this spirit I offer my imperfect sketch.

SECTION L.

EDUCATION.

Opening Address by the Right Hon. Sir John E. Gorst, F.R.S., President of the Section.

The invitation of the British Association to preside over the Section of Education, established this year for the first time, has been given to me as a representative of that Government Department which controls the larger, but perhaps not the most efficient, part of the education of the United Kingdom. The most suitable subject for my opening Address would therefore seem to be the proper function of National Authority, whether central or local, in the education of the people; what is the limit of its obligations; what is the part of Education in which it can lead the way; what is the region in which more powerful influences are at work, and in which it must take care not to hinder their operation; and what are the dangers to real education inseparable from a general national system. I shall avoid questions of the division of functions between Central and Local Authorities, beset with so many bitter controversies, which are political rather than educational.

In the first place, so far as the mass of the youth of a country is concerned, the Public Instructor can only play a secondary part in the most important part of the education of the young—the development of character. The character of a people is by far its most important attribute. It has a great deal more moment in the affairs of the world, and is a much more vital factor in the promotion of national power and influence, and in the spread of Empire, than either physical or mental endowments. The character of each generation depends in the main upon the character of the generation which precedes it; of other causes in operation the effect is comparatively small. A generation may be a little better or a little worse than its forefathers, but it cannot materially differ from them. Improvement and degeneracy are alike slow. The chief causes which produce formation of character are met with in the homes of the people. They are of great variety and mostly too subtle to be controlled. Religious belief, ideas, ineradicable often in maturer life, imbibed from the early instruction of parents, the principles of morality current amongst brothers and sisters and playmates, popular superstitions, national and local prejudices, have a far deeper and more permanent effect upon character than the instruction given in schools or colleges. The teacher, it is true, exercises his influence among the rest. Men and women of all sorts, from university professors to village dames, have stamped some part of their own character upon a large proportion of their disciples. But this is a power that must grow feebler as the number of scholars is increased. In the enormous schools and classes in which the public instruction of the greater part of the children of the people is given the influence on character of the individual teacher is reduced to a minimum. The old village dame might teach her half-dozen children to be kind and brave and to speak the truth, even if she failed to teach them to read and write. The head master of a school of 2000, or the teacher of a class of eighty, may be an incomparably better intellectual instructor, but it is impossible for him to exercise much individual influence over the great mass of his scholars.

There are, however, certain children for the formation of whose characters the nation is directly responsible—deserted children, destitute orphans, and children whose parents are criminals or paupers. It is the duty and interest of the nation to provide for the moral education of such children and to supply artificially the influences of individual care and love. The neglect of this obligation is as injurious to the public as to the children. Homes and schools are cheaper than prisons and workhouses. Such a practice as that of permitting dissolute pauper parents to remove their children from public control to spend the summer in vice and beggary at races and fairs, to be returned in the autumn, corrupt in body and mind, to spread disease and vice amongst other children of the State, would not be tolerated in a community intelligently alive to its own interest.

A profound, though indirect and untraceable, influence upon the moral education of a people is exercised by all national administration and legislation. Everything which tends to make the existing generation wiser, happier, or better has an indirect influence on the children. Better dwellings, unadulterated food, recreation grounds, temperance, sanitation, will all affect the character of the rising generation. Regulations for public instruction also influence character. A military spirit may be evoked by the kind of physical instruction given. Brutality may be developed by the sort of punishments enjoined or permitted. But all such causes have a comparatively slight effect upon national character, which is in the main the product for good or evil of more powerful causes which operate, not in the school, but in the home.

For the physical and mental development of children it is now admitted to be the interest and duty of a nation in its collective capacity to see that proper schools are provided in which a certain minimum of primary instruction should be free and compulsory for all, and, further, secondary instruction should be available for those fitted to profit by it. But there are differences of opinion as to the age at which primary instruction should begin and end; as to the subjects it should embrace; as to the qualifications which should entitle to further secondary instruction; and as to how far this should be free or how far paid for by the scholar or his parents.

The age at which school attendance should begin and end is in most countries determined by economic, rather than educational, considerations. Somebody must take charge of infants in order that mothers may be at leisure to work; the demand for child labour empties schools for older children. In the United Kingdom minding babies of three years old and upwards has become a national function. But the infant "school," as it is called, should be conducted as a nursery, not as a place of learning. The chief employment of the children should be play. No strain should be put on either muscle or brain. They should be treated with patient kindness, not beaten with canes. It is in the school for older children, to which admission should not be until seven years of age, that the work of serious instruction should begin, and that at first for not more than two or three hours a day. There is no worse mistake than to attempt by too early pressure to cure the evil of too early emancipation from school. Beyond the mechanical accomplishments of reading, writing, and ciphering, essential to any intellectual progress in after life, and dry facts of history and grammar, by which alone they are too often supplemented, it is for the interest of the community that other subjects should be taught. Some effort should be made to develop such faculties of mind and body as are latent in the scholars. The same system is not applicable to all; the school teaching should fit in with the life and surroundings of the child. Variety, not uniformity, should be the rule. Unfortunately, the various methods by which children's minds and bodies can be encouraged to grow and expand are still imperfectly understood by many of those who direct or impart public instruction. Examinations are still too often regarded as the best instrument for promoting mental progress; and a large proportion of the children in schools, both elementary and secondary, are not really educated at all—they are only prepared for examinations. The delicately expanding intellect is crammed with ill-understood and ill-digested facts, because it is the best way of preparing the scholar to undergo an Examination-test.

Learning to be used for gaining marks is stored in the mind by a mechanical effort of memory, and is forgotten as soon as the Class-list is published. Intellectual faculties of much greater importance than knowledge, however extensive—as useful to the child whose schooling will cease at fourteen as to the child for whom elementary instruction is but the first step in the ladder of learning—are almost wholly neglected.

The power of research—the art of acquiring information for oneself—on which the most advanced science depends, may by a proper system be cultivated in the youngest scholar of the most elementary school. Curiosity and the desire to find out the reason of things is a natural, and to the ignorant an inconvenient, propensity of almost every child; and there lies before the instructor the whole realm of Nature knowledge in which this propensity can be cultivated. If children in village schools spent less of their early youth in learning mechanically to read, write, and cipher, and more in searching hedgerows and ditch-bottoms for flowers, insects, or other natural objects, their intelligence would be developed by active research, and they would better learn to read, write, and cipher in the end. The faculty of finding out things for oneself is one of the most valuable with which a child can be endowed. There is hardly a calling or business in life in which it is not better to know how to search out information than to possess it already stored. Everything, moreover, which is discovered sticks in the memory and becomes a more secure possession for life than facts lazily imbibed from books and lectures. The faculty of turning to practical uses knowledge possessed might be more cultivated in Primary Schools. It can to a limited extent, but to a limited extent only, be tested by examination. Essays, compositions, problems in mathematics and science, call forth the power of using acquired knowledge. Mere acquisition of knowledge does not necessarily confer the power to make use of it. In actual life a very scanty store of knowledge, coupled with the capacity to apply it adroitly, is of more value than boundless information which the possessor cannot turn to practical use. Some measures should be taken to cultivate taste in Primary Schools. Children are keen admirers. They can be early taught to look for and appreciate what is beautiful in drawing and painting, in poetry and music, in Nature, and in life and character. The effect of such learning on manners has been observed from remote antiquity.

Physical exercises are a proper subject for Primary Schools, especially in the artificial life led by children in great cities: both those which develop chests and limbs, atrophied by impure air and the want of healthy games, and those which discipline the hand and the eye—the latter to perceive and appreciate more of what is seen, the former to obey more readily and exactly the impulses of the will. Advantage should be taken of the fact that the children come daily under the observation of a quasi-public officer—the school teacher—to secure them protection, to which they are already entitled by law, against hunger, nakedness, dirt, over-work, and other kinds of cruelty and neglect. Children's ailments and diseases should by periodic inspection be detected: the milder ones, such as sores and chilblains, treated on the spot, the more serious removed to the care of parents or hospitals. Diseases of the eye and all maladies that would impair the capacity of a child to earn its living should in the interest of the community receive prompt attention and the most skilful treatment available. Special schools for children who are crippled, blind, deaf, feeble-minded, or otherwise afflicted should be provided at the public cost, from motives, not of mere philanthropy, but of enlightened self-interest. So far as they improve the capacity of such children they lighten the burden on the community.

I make no apology for having dwelt thus long upon the necessity of a sound system of primary instruction: that is the only foundation upon which a national system of advanced education can be built. Without it our efforts and our money will be thrown away. But while primary instruction should be provided for, and even enforced upon, all, advanced instruction is for the few. It is the interest of the commonwealth at large that every boy and girl showing capacities above the average should be caught and given the best opportunities for developing those capacities. It is not its interest to scatter broadcast a huge system of higher instruction for anyone who chooses to take advantage of it, however unfit to receive it. Such a course is a waste of public resources. The broadcast education is necessarily of an inferior character, as the expenditure which public opinion will at present sanction is only sufficient to provide education of a really high calibre for those whose ultimate attainments will repay the nation for its outlay on their instruction. It is essential that these few should not belong to one class or caste, but should be selected from the mass of the people, and be really the intellectual *élite* of the rising generation. It must, however, be confessed that the arrangements for selecting these choice scholars to whom it is remunerative for the community to give advanced instruction are most imperfect. No "capacity-catching machine" has been invented which does not perform its function most imperfectly: it lets go some it ought to keep, and it keeps some it ought to let go. Competitive examination, besides spoiling more or less the education of all the competitors, fails to pick out those capable of the greatest development. It is the smartest, who are also sometimes the shallowest, who succeed. "Whoever thinks in an examination," an eminent Cambridge tutor used to say, "is lost." Nor is position in class obtained by early progress in learning an infallible guide. The dunce of the school sometimes becomes the profound thinker of later life. Some of the most brilliant geniuses in art and science have only developed in manhood. They would never in their boyhood have gained a county scholarship in a competitive examination.

In Primary Schools, while minor varieties are admissible, those, for instance, between town and country, the public instruction provided is mainly of one type; but any useful scheme of higher education must embrace a great variety of methods and courses of instruction. There are roughly at the outset two main divisions of higher education—the one directed to the pursuit of knowledge for its own sake, of which the practical result cannot yet be foreseen, whereby the "scholar" and the votary of pure science is evolved; the other directed to the acquisition and application of special knowledge by which the craftsman, the designer, and the teacher are produced. The former of these is called Secondary, the latter Technical, Education. Both have numerous subdivisions which trend in special directions.

The varieties of secondary education in the former of these main divisions would have to be determined generally by considerations of age. There must be different courses of study for those whose education is to terminate at sixteen, at eighteen, and at twenty-two or twenty-three. Within each of these divisions, also, there would be at least two types of instruction, mainly according as the student devoted himself chiefly to literature and language, or to mathematics and science. But a general characteristic of all Secondary Schools is that their express aim is much more individual than that of the Primary School: it is to develop the potential capacity of each individual scholar to the highest point, rather than to give, as does the Elementary School, much the same modicum to all. For these reasons it it essential to have small classes, a highly educated staff, and methods of instruction very different from those of the Primary School. In the formation of character the old Secondary Schools of Great Britain have held their own with any in the world. In the rapid development of new Secondary Schools in our cities it is most desirable that this great tradition of British Public School life should be introduced and maintained. It is not unscientific to conclude that the special gift of colonising and administering dependencies, so characteristic of the people of the United Kingdom, is the result of that system of self-government to which every boy in our higher Public Schools is early initiated. But while we boast of the excellence of our higher schools on the character-forming side of their work, we must frankly admit that there is room for improvement on their intellectual side. Classics and mathematics have engrossed too large a share of attention; science, as part of a general liberal education, has been but recently admitted, and is still imperfectly estimated. Too little time is devoted to it as a school subject: its investigations and its results are misunderstood and undervalued. Tradition in most schools, nearly always literary, alters slowly, and the revolutionary methods of science find all the prejudices of antiquity arrayed against them. Even in scientific studies, lack of time and the obligation to prepare scholars to pass examinations cause too much attention to be paid to theory, and too little to practice, though it is by the latter that the power of original research and of original application of acquired knowledge is best brought out. The acquisition of modern languages was in bygone generations almost entirely neglected. In many schools the time given to this subject is still inadequate, the method of teaching antiquated, the results unsatisfactory. But the absolute necessity of such knowledge in literature, in science, and in commerce is already producing a most salutary reform.

The variety of types of secondary instruction demanded by the various needs and prospects of scholars requires a corresponding variety in the provision of schools. This cannot be settled by a rule-of-three method, as is done in the case of primary instruction. We cannot say that such and such an area being of such a size and of such a population requires so many secondary schools of such a capacity. Account must be taken in every place of the respective demands for respective types and grades of secondary education; and existing provision must be considered.

It must not, however, be forgotten that a national system of education has its drawbacks as well as its advantages. The most fatal danger is the tendency of public instruction to suppress or absorb all other agencies, however long established, however excellent their work, and to substitute one uniform mechanical system, destructive alike to present life and future progress. In our country, where there are public schools of the highest repute carried on for the most part under ancient endowments, private schools of individuals and associations, and Universities entirely independent of the Government, there is reasonable hope that with proper care this peril may be escaped. But its existence should never be forgotten. Universal efficiency in all establishments that profess to educate any section of the people may properly be required; but the variety, the individuality, and the independence of schools of every sort, primary and secondary, higher and lower, should be jealously guarded. Such attributes once lost can never be restored.

There still remains for our consideration the second division of Higher Education, viz., the applied or technological side. It is in this branch of Education that Great Britain is most behind the rest of the world; and the nation in its efforts to make up the lost ground fails to recognise the fact that real technical instruction (of whatever type) cannot possibly be assimilated by a student unless a proper foundation has been laid previously by a thorough grounding of elementary and secondary instruction. Our efforts at reform are abrupt and disconnected. A panic from time to time sets in as to our backwardness in some particular branch of commerce or industry. There is a sudden rush to supply the need. Classes and schools spring up like mushrooms, which profess to give instruction in the lacking branch of applied science to scholars who have no elementary knowledge of the particular science, and whose general capacities have never been sufficiently developed. Students are invited to climb the higher rungs of the ladder of learning who have never trod the lower. But science cannot be taught to those who cannot read, nor commerce to those who cannot write. A few elementary lessons in shorthand and book-keeping will not fit the British people to compete with the commercial enterprise of Germany. Such sudden and random attempts to reform our system of technical education are time and money wasted. There are grades and types in technological instruction, and progress can only be slow. It is useless to accept in the higher branches a student who does not come with a solid foundation on which to build. In such institutions as the Polytechnics at Zurich and Charlottenburg we find the students exclusively drawn from those who have already completed the highest branches of general education; in this country there is hardly a single institution where this could be said of more than a mere fraction of its students. The middle grades of technological instruction suffer from a similar defect. Boys are entered at technical institutions whose only previous instruction has been at elementary schools and evening classes; whose intellectual faculties have not been developed to the requisite point; and who have to be retaught the elements to fit them for the higher instruction. In fact there is no scientific conception of what this kind of instruction is to accomplish, and of its proper and necessary basis of general education.

Yet this is just the division of higher education in which public authority finds a field for its operations practically unoccupied. There are no ancient institutions which there is risk of supplanting. The variety of the subject itself is such that there is little danger of sinking into a uniform and mechanical system. What is required is first a scientific, well-thought-out plan and then its prompt and effective execution. A proper provision of the various grades and types of technological instruction should be organised in every place. The aim of each institution should be clear; and the intellectual equipment essential for admission to each should be laid down and enforced. The principles of true economy, from the national point of view, must not be lost sight of. Provision can only be made (since it must be of the highest type to be of the slightest use) for those really qualified to profit by it to the point of benefiting the community. Evening classes with no standard for admission and no test of efficiency may be valuable from a social point of view as providing innocent occupation and amusement, but they are doing little to raise the technical capacity of the nation. So far from "developing a popular demand for higher instruction" they may be preventing its proper growth by perpetuating the popular misconception of what real technical instruction is, and of the sacrifices we must make if our people are to compete on equal terms with other nations in the commerce of the world. The progress made under such a system would at first be slow; the number of students would be few until improvements in our systems of primary and secondary instruction afforded more abundant material on which to work; but our foundation would be on a rock, and every addition we were able to make would be permanent, and contribute to the final completion of the edifice.

It is the special function of the British Association to inculcate "a scientific view of things" in every department of life. There is nothing in which scientific conception is at the present moment more urgently required than in National Education; and there is this peculiar difficulty in the problem, that any attempt to construct a national system inevitably arouses burning controversies, economical, religious, and political. It is only a society like this, with an established philosophical character, that can afford to reduce popular cries about education (which ignore what education really is, and perpetuate the absurdity that it consists in attending classes, passing examinations, and obtaining certificates) to their true proportions. If this Association could succeed in establishing in the minds of the people a scientific conception of a National Education System, such as has already been evolved by most of the nations of Europe, the States of America, and our own Colonies, it would have rendered a service of inestimable value to the British nation.

GEOLOGY AT THE BRITISH ASSOCIATION.

An arduous week's work was carried out in the Section of Geology at Glasgow. There was a full list of papers—in fact, too full for adequate discussion of all—ranging widely over the whole group of sciences combined under the name of geology. While stratigraphical papers were, as usual, in the ascendancy, petrology and palæontology were both strongly represented, mineralogy (with crystallography), of late years somewhat neglected in this Section, counted several contributions, and matters of physical and economic geology received attention in others. Many of the papers were admirably adapted for initiating discussion, and in some instances fulfilled this purpose, though, as generally happens with a heavy list, the discussions were somewhat unequally distributed. It might, perhaps, be said of many of the papers that they were instructive summaries of what was already known rather than new additions to our knowledge. The general arrangement was that the papers dealing with Scottish geology were taken as far as possible on Thursday and Friday, Saturday was given up to excursions, palæontological subjects occupied most of the Monday sitting, mineralogical papers were given precedence on Tuesday, and the concluding session on Wednesday served for the postponed or unclassified contributions. In the following outline of the proceedings of the Section we shall not have space to mention all the papers which were read, and must content ourselves with brief mention of those which seemed to us to be of chief interest.

After the president's address on Thursday, already printed in our columns, a paper on recent discoveries in Arran geology, by Mr. W. Gunn, of H.M. Geological Survey, read by Mr. Peach, gave a general summary of recent important advances in our knowledge of the island. Among its older rocks a series of dark schists and chert, unfossiliferous but probably of Arenig age, have been discovered; the Old Red Sandstone has been found to comprise two subdivisions, of which the upper is unconformable on the lower; the Carboniferous, including beds probably of Coal Measure age, are overlapped unconformably by the New Red rocks, the latter consisting of sandstones, conglomerates and marls which seem to be of Triassic age.

Fragments of Rhætic, Liassic and Cretaceous rocks which must once have covered the area have been recognised by their fossils in a large volcanic vent; this volcano was probably of Tertiary age, to which period are also assigned most of the igneous rocks, though six earlier periods of volcanic activity have been now recognised in this most interesting island.

Mr. G. Barrow followed with a suggestive paper on lateral variations of composition in zones of the Eastern Highland schists, which he ascribed to original variation in the sediments deposited in a delta. Mr. P. Macnair then gave his interpretation of the structure and probable succession of the schists of the Southern Highlands, which he considers to form an ascending sequence in the following order: Lower Argillaceous zone, Lower Arenaceous zone, Loch Tay Limestone, Garnetiferous schist, Upper Argillaceous zone and Upper Arenaceous zone.

The differentation of a rock-magma was well illustrated by Prof. J. Geikie and Dr. J. S. Flett in their description of the granite of Tulloch Burn, Ayrshire, which passes at its margins into intermediate and basic rocks.

The occurrence of a phosphatic layer at the base of the Inferior Oolite in Skye, lining a hollow of local erosion in the Upper Lias shales, was briefly described in a paper by Mr. H. B. Woodward.

On Friday the first paper was a lucid account by Sir Arch. Geikie of the re-discovery of a tree-trunk embedded in volcanic ash in Mull. This tree was described long ago by Macculloch, but occurs in a sea-cliff very difficult of access, and received no further notice until visited recently by Sir Arch. Geikie. The stump is about 5 feet in diameter and 5 feet high, and must have belonged to a tree originally at least 80 feet high. It is of peculiar interest in showing that time-intervals of quiescence of considerable length occurred between separate volcanic outbursts.

Another notable contribution to Scottish volcanic geology was made by Mr. A. Harker in a paper on the sequence of the Tertiary igneous eruptions in Skye, read by Dr. Flett in the absence of the author. As the result of his detailed mapping of the volcanic rocks of Skye for the Geological Survey, Mr. Harker finds that he can recognise three successive phases of igneous activity—the *volcanic*, the *plutonic*, and the phase of *minor intrusions*. He further distinguishes two parallel series of events—the *regional* and the *local*, the former of very wide extension, the latter connected with certain definite foci, one of which was situated in Central Skye.

The *regional* eruptive rocks are all of basic composition, but the *local* groups exhibit much greater diversity. During the plutonic phase the successive groups of intrusions at the Skye centre followed an order of increasing acidity; but for the local groups of the succeeding phase of minor intrusions this order was reversed. Mr. Harker suggests that this sequence of Tertiary igneous eruptions may probably be taken as a type of the whole British area; and we may be sure that all students of these difficult rocks will await with impatience the publication of the detailed observations on which Mr. Harker's far-reaching generalisations are based.

Two papers by Messrs. A. McHenry and J. R. Kilroe, of the Irish branch of the Geological Survey, dealing with the older rocks of the north-west of Ireland and their bearing on Scottish geology, were next read. In the first the authors called attention to the close resemblance of the Old Red Sandstone of north-west Ireland to the Torridon rocks of Sutherland both in composition and structural relationships, and suggested that the Torridon rocks were therefore really of Old Red age. This paper gave rise to an animated discussion, in which Profs. Sollas, Lapworth and Hull, Messrs. Peach, Barrow, Greenly, Goodchild, Caddell, Hinxman, Craig and the President took part. The consensus of opinion was that the suggested new reading of the Torridon succession could not be sustained; and one of the speakers aptly proposed that as the question had been well-threshed out, an abstract of the discussion should be printed as a permanent record of the evidence for the age of the Scottish Torridonian.

Messrs. Kilroe and McHenry's second paper dealt with the relation of the Silurian and Ordovician rocks of north-west Ireland to the Great Metamorphic Series, their contention being that the latter consisted of metamorphosed Lower Silurian sediments and associated intrusions, over which the unmetamorphosed rocks were carried by overfolding and great dislocations in Llandovery times. In the next paper on the list, by Mr. G. H. Kinahan, this view was controverted, and the earlier age of the metamorphic series upheld, these being compared with the Algonkian of North America.

Dr. Traquair then gave interesting lantern demonstrations on the geological distribution of the fishes of the Carboniferous rocks and of the Old Red Sandstone of Scotland. The study of the Carboniferous fish-faunas led to the conclusion that the rocks were divisible into two parts—Upper and Lower Carboniferous, with a great break at the base of the Millstone Grit, the Upper Carboniferous fauna being like that of England, and that of the Lower Carboniferous differing only where fresh-water or estuarine conditions displaced the marine forms. At a later session similar results were presented by Mr. R. Kidston in his description of fossil plants from Berwickshire.

In the concluding papers on Friday the Section was carried far afield by Miss C. A. Raisin in her account of the volcanic rocks of Perim Island, and by Dr. R. Logan Jack in his description of the conditions under which enormous supplies of artesian water are obtained in Queensland, where borings of the aggregate length of 185 miles have been made with incalculable advantage to the country, as the result of geological investigations in which Dr. Jack was a pioneer. The deepest of these borings attained the exceptional depth of 5045 feet.

On Monday, when precedence was given to palæontological papers, Mr. B. N. Peach came first with an admirable *résumé* of our knowledge of the Cambrian fossils of the North-West Highlands, in which stress was laid on the close agreement between the Scottish and North American fossil zones of this ancient period, betokening a shore-line connection between the continents, with a deep-water barrier to the southward, separating the north of Scotland from the mid-European and Welsh areas.

Prof. Sollas then exhibited and explained his machine for investigating fossil-remains. By Prof. Sollas's method the fossil is ground down slowly, and a series of parallel sections obtained from which it is easy to construct a model of the whole fossil. The great value of this machine as an instrument of research was demonstrated by a series of lantern slides and by wax models.

Mr. A. M. Bell gave an account of the plants and coleoptera from a Pleistocene deposit at Wolvercote, Oxfordshire; the plants indicated a more continental climate of the Thames valley during the period than at present, and a later date for the deposit than the Hoxne beds.

Papers on glacial geology were fewer than of late years, and indeed, with the exception of the Report of the Erratic Blocks Committee, the only strictly glacial paper was that of Prof. P. F. Kendall and H. B. Muff on overflow channels and other phenomena indicating glacier-dammed lakes in the Cheviots, in which region these observers have recently recognised similar phenomena to those which they had previously investigated in Yorkshire.

The application of geology to agriculture by the preparation of soil maps was the subject of a communication by Mr. J. R. Kilroe, who exhibited a specimen-map, on which the general character of the soil was indicated by a few colours selected from those of our usual geological maps, but intended to show the soil-characters only, without particular reference to the geological structure.

Tuesday was primarily the mineralogists' day, and the session was opened by Mr. J. G. Goodchild with a paper on the Scottish ores of copper in their geological relations, in which these ores were classed into two primary categories, those of the first being assigned to the uprise of thermal waters, and of the second to solutions passing downwards from higher to lower levels. The same author, in another communication, dealt with a revised list of Scottish minerals, and indicated its more salient points. Dr. W. Mackie followed with a series of three papers on the Trias of Elgin and Nairn, one describing the occurrence of barium sulphate and calcium fluoride as cementing substances in the Elgin area, believed by the author to have been directly deposited during the concentration of the waters of an inland lake; another recording covellite and malachite in a vein in the sandstone of Kingsteps, Nairn; and the third, on which there was an excellent discussion, on the pebble-band of the Elgin Trias, which was shown to be of wider extent than hitherto supposed and to mark a definite horizon at the base of the Trias, the overlying Cutties Hillock sandstones being really made up of Triassic sand-dunes, while in the pebble-bed many of the stones present characters showing them to have been wind-worn. At this point we may also mention a mineralogical paper by Dr. J. S. Flett, read at an earlier session, on crystals dredged from the Clyde near Helensburgh, which are believed to be pseudomorphs after celestine.

In a paper on the source of the alluvial gold of the Kildonan field, Sutherland, Mr. J. Malcolm Maclaren, as the result of a recent investigation, concludes that the gold has been derived from the white quartz veins of the local schists, whence it has been distributed into the glacial-drift and finally concentrated mechanically in the present stream-courses. In a second paper Mr. Maclaren dealt with the influence of organic matter on the deposition of gold in veins, from personal observation on the reefs of the Sympic and Croydon goldfields of Queensland and of the Ballarat field of Victoria, giving illustrations of the enrichment of the veins at the contact with carbonaceous or graphitic rocks, and suggesting the possibility of precipitation by carbonaceous matter, in accordance with the opinion once generally held, but latterly much discredited.

Mr. E. H. Cunningham Craig described the mode of occurrence of cairngorms, the search for which was formerly a profitable Scottish industry, but has now been practically abandoned. These idiomorphic quartz-crystals occur in the drusy central zones of veins of fine-grained granite traversing the normal coarser and less acid granites.

Prof. Joly's computations of the age of the earth from the amount of salt in the sea were incidentally criticised by Mr. W. Ackroyd in a paper on the circulation of salt and its geological bearings. It was shown by Mr. Ackroyd that for the Millstone Grit and limestone districts of Yorkshire, as well as for a belt of the American coast some 200 miles broad, fully 99 per cent. of the salt carried by the rivers was cyclic sea-salt which had been atmospherically transported and carried down by rain, while Prof. Joly allows only 10 per cent. as the proportion thus derived in our rivers. Reference was made to estimates by the author that during 1900–1901 the deposition of salt derived from the sea amounted to 172·3 lbs. per acre per year on the Pennine Hills at over 1000 feet above sea-level.

At the same session Mr. W. H. Wheeler discussed the sources of the warp in the Humber, urging that the material was brought down by the rivers flowing into the Humber, and not by the inflowing tide from the waste of the Holderness coast as has been authoritatively stated. Two papers by Mr. J. Rhodes were also read, describing the discovery of phosphatic nodules and phosphate-bearing rock in the Upper Carboniferous Limestone series on the Yorkshire and Westmorland border, and of a silicified plant seam in the same locality.

There still remained a list of ten papers and reports to be taken at the final meeting on Wednesday, the majority being papers dealing with foreign geology. Dr. A. Smith Woodward sent an account of his recent investigations of the famous bone-beds of Pikermi, Attica, where in re-working the old locality he obtained fragmentary evidence of a gigantic tortoise at least as large as the largest hitherto found in Europe, and in a new locality, at Achmet Aga in North Eubœa, sixty miles distant from the former, he found a similar bone-bed, probably formed in like manner by torrential floods carrying down their débris into lakes.

Mr. H. J. L. Beadnell, of the Geological Survey of Egypt, also sent an account of the discovery of bone-beds of early Tertiary age in the Fayum depression, which have yielded many new mammalian and reptilian remains now being worked out by Dr. C. W. Andrews, of the British Museum, who visited the locality with Mr. Beadnell.

Prof. E. Hull, in continuance of his researches on submarine physiography, discussed the physical history of the Norwegian fjords. These he believes to be essentially river-valleys, of which the lower portions, probably once deep gorges traversing what is now the open sea-floor, are entirely filled with drift, and thus obliterated.

The origin of the gravel flats of Surrey and Berkshire was discussed by Mr. H. W. Monckton, who concludes that these deposits were river-gravels formed since the country last rose above the sea, during periods of repose in the process of elevation, which was differential in its effects.

As usual, much of the best work brought before the Section was embodied in the Reports of Committees of Research, for which, unfortunately, we have barely space for mention. The report of the Geological Photographs Committee, by Prof. W. W. Watts, and that on Erratic Blocks, by Prof. P. F. Kendall, showed the same substantial progress which these vigorous committees customarily present. The report on Carboniferous Life-zones, by Dr. Wheelton Hind, and that on the Underground Waters of N.W. Yorkshire, by Captain A. R. Dwerryhouse, though hampered by unforeseen local difficulties in the latter case, also showed solid progress; while that on the Exploration of Irish Caves gave a preliminary account of the good results attained by the first year's working at Keish, co. Sligo; and that on the Structure of Crystals (drawn up by Mr. W. Barlow and Prof. H. A. Miers, assisted by Mr. G. F. Herbert Smith) forms an invaluable contribution to the history of crystallographic research.

As usual there were afternoon excursions during the meeting to places of geological interest within easy reach of Glasgow, besides the whole-day excursions to Girvan, Arran, Loch Lomond and The Trossachs on Saturday. The attendance at the sectional meetings throughout was quite up to the average of recent years, and general satisfaction was expressed with the character of the proceedings of Section C at Glasgow.

ZOOLOGY OF THE TWENTIETH CENTURY.[1]

WE have stood in retrospect at the close of the nineteenth century and marvelled at what it brought forth. Here at the threshold of the twentieth century it is natural that we should wonder what it will unfold. Will the changes be as great and in what direction will advance chiefly be made? I am the more content to consider such questions for three reasons: first, because we can use history to formulate predictions; second, because the attempt may possibly influence to some slight degree the future development of zoology; and third, because the attempt is tolerably safe since we shall none of us know all that the century will bring forth.

Comparing the beginning of the twentieth century with that of the nineteenth we find the most striking advances to have taken place in our morphological knowledge. The nineteenth may, indeed, be designated the morphological century. The demands of systematic zoology first made anatomical studies necessary. Later, comparison came to be accepted as the fundamental zoological method, and comparative anatomy, emancipated from its servitude to systematic zoology, became an independent science. Still later embryology arose, at first as a descriptive science and then as a comparative one. Out of embryology arose modern cytology, which in turn is creating a comparative histology. Partly as a result of studying embryology as a process has arisen the modern tendency toward comparative physiology. As a result of the general acceptance of the evolution doctrine the study of the geographical distribution of organisms and of adaptations has gained a new meaning. From the great matrix of "general biology" there have begun to crystallise out a number of well-defined subsciences.

Looking broadly at the progress made during the past century we see that zoology has become immensely more complex due to its developing in many lines, and that the new lines are largely interpolated between the old and serve to connect them. The descriptive method has developed into a higher type—the comparative; and of late years still a new method has been introduced for the study of processes—the experimental. The search for mechanisms and causes has been added to the search for the more evident phenomena. The zoologist is no longer content to collect data; he must interpret them.

In view of the past history of our science what can we say of its probable future? We may be sure that zoology will develop in all these three directions: (1) The continued study of old subjects by old methods; (2) the introduction of new methods of studying old subjects; and (3) the development of new subjects.

I am not of those who would belittle the old subjects, even when pursued in the old way. There is only one class of zoologist that I would wish to blot out, and that is the class whose reckless naming of new "species" and "varieties" serves only to extend the work and the tables of the conscientious synonymy hunter. Other than this all classes will contribute to the advancement of the science. No doubt there are unlabled species and no doubt they must, as things are, be named. And no doubt genera and families must be "revised" and some groups split up and others lumped. So welcome to the old-fashioned systematist, though his day be short, and may

[1] Address delivered before the Section of Zoology of the American Association for the Advancement of Science, at Denver, by Prof. C. B. Davenport, president of the Section

he treat established genera gently. No doubt there are types of animals of whose structure we are woefully ignorant; no doubt we need to know their internal anatomy in great detail. So welcome to the zootomist in this new century, and may he invent fewer long names for new organs. No doubt there are groups of whose relationships we know little, and which have been buffeted about from one class to another in a bewildering way. We need to have their places fixed. So welcome to the comparative anatomist and the embryologist, and may their judgment as to the relative value of the criteria of homology grow clearer. No doubt our knowledge of inheritance and development will be immensely advanced by the further study of centrosomes, asters and chromosomes. Welcome, therefore, to the cytologist, and may he learn to distinguish coagulation products and plasmolytic changes from natural structures. All these subjects have victories in store for them in the new century. To neglect them is to neglect the foundations of zoology.

But the coming century will, I predict, see a change in the methods of studying many of these subjects. In systematic zoology fine distinctions will no longer be expressed by the rough language of adjectives, but quantitatively, as a result of measurement. There is every reason to expect, indeed, that the future systematic work will look less like a dictionary and more like a table of logarithms. Our system of nomenclature, meanwhile, will probably break down from its own weight. Now that the binomial system of nomenclature has been replaced by a trinomial, there is no reason why we should not have a quadrinomial nomenclature or even worse. It seems as if the Linnæan system of nomenclature is doomed. What will take its place can hardly be predicted. The new system should recognise the facts of place-modes and colour-varieties. We might establish certain categories of variation such as those of geographical regions, of habitat, of colour. A decimal system of numbers might be applied to the parts of the country or the kinds of habitat and the proper number might take the place of the varietal or subvarietal name. Thus the north-eastern skunk might be designated *Mephitis mephitica* 74, and the south-eastern skunk *Mephitis mephitica* 75 (adopting the Dewey system of numerals). The Maine skunk would then be 741, that of New York 747, and so on. This much for a suggestion.

So likewise for the morphologist the coming century will bring new aims and new methods. No longer will the construction of phylogenetic trees be the chief end of his studies, but a broad understanding of the form producing and the form maintaining processes. The morphologist will more and more consider experiment a legitimate method for him. The experimental method will, I take it, be extended especially to the details of cytology, and here cytology will make some of its greatest advances.

Not only will the old subjects be studied by new methods, but we have every reason to believe that new subsciences will arise during the twentieth century as they arose during the nineteenth. Of course we cannot forecast all of these unborn sciences, as cytology and neurology could hardly have been forecast at the beginning of the nineteenth century. But we can see the beginnings of what are doubtless to be distinct sciences. Thus comparative physiology is still in its infancy, and is as yet hardly worthy of the name of a science; there is no question that this will develop in the coming decades. Animal behaviour has long been treated in a desultory way, and many treatises on the subject are rather contributions to folk-lore than to science. But we are beginning to see a new era—an era of precise, critical and objective observation and record of the instincts and reactions of animals. One day we shall reach the stage of comparative studies and shall have a science of the ontogeny of animal instincts. This will have the same importance for an interpretation of human behaviour that comparative anatomy and embryology have for human structure.

Prominent among the advances of the century will be the ability to control biological processes. We shall know the factors that determine the rate of growth and the size of an animal, the direction and sequence of cell-divisions, the colour, sex and details of form of a species. The direction of ontogeny and of phylogeny will be to a greater or less extent under our control.

The study of animals in relation to their environment, long the pastime of country gentlemen of leisure, will become a science. Some day we shall be able to say just what determines an animal's presence at any place; and, more than that, we shall be able to account for the fauna, the sum total of animal life of any locality, and to trace the history of that fauna. This is at least one of the aims of animal ecology. It is a reproach to zoology that the subject of animal ecology should lag so far behind that of plant ecology. When zoologists fully awaken to a realisation of what a fallow field lies here this reproach will quickly be wiped out. As it is we have a notion that the factors determining the occurrence of an animal or of a fauna are too complicated to be unravelled. As a matter of fact the factors are often quite simple. Let me illustrate this by some studies I have made this summer on the Cold Spring Beach. This beach is a spit of sand 2000 feet long and 50 to 75 feet broad, running from the western mainland into the harbour and ending in a point that is being made several feet a year through the cooperation of wave, tide, and a silt-transporting creek of fresh water. On the outer harbour side is a broad, gradually sloping sandy and gravelly beach, covered by high tide, and devoid of living vegetation. Above that is a narrow zone—the middle beach—covered with the débris of storms, supporting a few annual plants, and bounded above by a storm-cut bluff. Above is the upper beach, covered with a perennial, sand-loving vegetation. On the lower beach the zonal distribution of animals is striking. Just above the water are found the scavenger mud-snails, and, further up, a crowd of Thysanura—small insects that rise to the surface of the water when the tide comes in. These find a living on the finer débris or silt that settles on the pebbles during the high tides. In this zone also Limulus lays its eggs in the sand, and its nests are crowded with nematodes that feed on the eggs. During the breeding season scores of the female Limulus die here, and their carcasses determine a complex fauna. First, carrion beetles (Necrophorus) and the flesh fly live on the dead bodies; then the robber flies and tiger-beetles are here to feed on this fauna, and, finally, numerous swallows course back and forth, gleaning from this rich field. At the upper edge of the lower beach is a band of débris dropped at slack water and consisting especially of shreds of Ulva and many drowned insects, especially beetles. At this zone or just above, under the drier but more abundant wreckage of the last storm, occur numerous Amphipoda of the genera Orchestia and Talorchestia. Associated with these marine creatures are numerous red ants, sand-coloured spiders and rove-beetles. The amphipods feed on the decaying sea-weed. The ants are here looking chiefly for the drowned insects. Their nests are further up on the middle beach, but the workers travel to the edge of the high tide to bring away their booty. The rove-beetles are general scavengers. The spiders, which are mostly of the jumping sort (of the family Attidæ), feed on the active insects and amphipods. At a higher zone and above all but the storm-driven tides one finds the nests of the ants, especially under logs, certain predaceous beetles and the xerophilous grasshoppers and crickets. Finally, on the plant-covered upper beach one finds characteristic leaf-eating beetles, grasshoppers and carnivorous insects. Now all this seems commonplace enough and not especially instructive, and yet if you go to the shore of Lake Michigan you will find on a similar beach closely similar, if not identical, forms (excepting the beach fleas and the horse-shoe crabs); you will find similar ants, spiders, rove-beetles, tiger-beetles and sand grasshoppers. This fact alone shows the greater importance of habitat over geographical region in determining the assemblage of animals that occurs in any one place. It may be predicted that studies on the relation of animals to their habitat will multiply, that they will become comparative and that the science of animal ecology will become recognised as no less worthy and no less scientific than the science of morphology.

Studies on the origin of species were far from being unknown in the nineteenth century, but they were for the most part fragmentary or speculative or narrow in view. The opinion that there was one method of evolution seemed to hold sway. It seems to me that the signs of the times indicate that we are about to enter upon a thorough, many-sided, inductive study of this great problem, and that there is a willingness to admit that evolution has advanced in many ways. The attempt, therefore, to explain all specific peculiarities on the ground of natural selection, or on the ground of self-adjustment, or on the ground of sport-preservation through isolation we may expect equally to prove futile. All these causes are no doubt real in some cases, but to exclude any one or to deny that new causes may be found in the future is equally dangerous and unscientific.

It is often said that the factors of evolution are inheritance and variation. In the new century careful and quantitative studies will be made on these factors. We shall get at quantitative expressions of the more complicated forms of heritage in the same way as Galton has given us an expression of a simple form of inheritance. We shall hope to understand why some qualities blend and others refuse to do so. We shall learn the laws of mingling of qualities in hybrids and get an explanation of the monstrosities and the sterility which accompany hybridisation. What we call reversion and prepotency will acquire a cytological explanation, and it may be that the theory of fertilisation will be seriously modified thereby. When we can predict the outcome of any new combination of germplasms, then, indeed, we shall have got at the laws of inheritance.

As for the other factor, that of variation, I anticipate interesting developments in our knowledge of its laws and of its causes. The methods by which this knowledge is to be acquired are doubtless comparative observation, experimentation and a quantitative study of results. Within the last decade a profouud student of variation (Bateson) has declined to discuss its causes, holding that we had no certain knowledge of them. Even the categories of variation are still unenumerated. The science of variation is therefore one of those that we may hope to see established in this century. I feel convinced that statistical studies are first of all necessary to lay the foundations of the science.

As an illustration o. an application of statistics to evolution studies I will give some account of my work during the past two years on the scallop of our east coast, *Pecten irradians*.

Pecten irradians is a bivalve mollusc of flattened lenticular form that inhabits our coast from Cape Cod southward. The Cape Cod limit is a rather sharp one, but southward our scallop passes gradually into the closely related forms of the South American coast. This fact would seem to indicate its southerly origin. To get light on the evolution of the group, I have studied and measured more than 3000 shells, chiefly from four localities:—(1) Cold Spring Harbour, Long Island; (2) Morehead, North Carolina; (3) Tampa, Florida; and (4) the late Miocene or early Pliocene fossils of the Nansemond River. The fossil shells, to which I shall frequently refer, were found embedded in the sand of Jack's Bank, one mile below Suffolk, Virginia. The bank rises to a height of twenty-five to thirty feet. Shells were obtained from three layers, respectively one foot, six feet and fifteen feet above the base of the bluff. Of course, the upper shells lived later than the lower ones and may fairly enough be assumed to be their direct descendants. The time interval between the upper and lower levels cannot be stated. As I have measured sufficient shells from the bottom and top layers only I shall consider them chiefly. I wished to get recent Pectens from this locality, but the nearest place where they occur in quantity is Morehead, North Carolina. These Pectens may therefore stand as the nearest recent descendants of the Pectens of the Nansemond River.

The Pecten shells have a characteristic appearance in each of the localities studied. After you have handled them for some time you can state in 95 per cent. of the cases the locality from which any random shell has come. First of all the shells differ in colour, especially of the lower valve. In the specimens from Cold Spring Harbour this is a dirty yellow, from Morehead, yellow to salmon, from Tampa, white through clear yellow to bright salmon. Second, the anterio-posterior diameter of the shell becomes relatively greater than the vertical diameter as you go north. Thus the anterio-posterior diameter exceeds, on the average, the dorso-ventral diameter: at Tampa, by about 1·5 mm.; at Morehead, 2·5 mm.; and at Cold Spring Harbour, 6 mm. The fossil Pectens have an excess of about 4 mm.

Comparing the fossils with the Pectens of Morehead we find, as shown above, that the fossils are more elongated. Comparing the depth of the right valves having a height of 59 mm. we get:—

From the lowest level, Jack's Bank ...	8·8 mm.
,, ,, highest ,, ,, ,, ...	9·1 mm.
,, Morehead	19·7 mm.

Hence the recent shells are much more nearly spherical than the fossils—there is a phylogenetic tendency toward increased globosity.

The average number of rays in the different localities is as follows:—

Lower level, Jack's Bank	22·6
Middle ,, ,, ,, ...	22·1
Upper ,, ,, ,, ...	21·7
Morehead and Cold Spring Harbour	17·3
Tampa	20·5

Here it appears that there is a phylogenetic tendency toward a decrease in the number of rays of *Pecten irradians*. To summarise: the scallop is becoming, on the average, more globose, and the number of its rays is decreasing, and its valves are probably becoming more exactly circular in outline. The foregoing examples illustrate the way in which quantitative studies of the individuals of a species can show the change in its average condition, both at successive times and in different places.

But the quantitative method yields more than this. It is well known that if the condition of an organ is expressed quantitatively in a large number of individuals of a species the measurements or counts made will vary, *i.e.* they will fall into a number of classes. The proportion of individuals falling into a class gives what is known as the "frequency" of the class. Now it appears that in many cases the middle class has the greatest frequency (and is consequently called the mode), and as we depart from it the frequency gradually diminishes, and diminishes equally at equal distances above and below the mode. One can plot the distribution of frequencies by laying off the successive classes at equal intervals along a base line and drawing perpendiculars at these points proportional in length to the frequency. If the tops of these perpendiculars be connected by a line there is produced a "frequency polygon." The shape of the frequency polygon gives much biological information. When the polygon is symmetrical about the modal ordinate we may conclude that no evolution is going on; that the species is at rest. But very often the polygon is more or less unsymmetrical or "skew." A skew polygon is characterised by this, that the curve runs from the mode further on one side than on the other. This result may clearly be brought about by the addition of individuals to one side or their subtraction from the other side or the normal frequency curve. The direction of skewness is toward the excess side. The skew frequency polygon indicates that the species is undergoing an evolutionary change. Moreover, the direction and degree of skewness may tell us something of the direction and rate of that change. There is one difficulty in interpretation, however, for a polygon that is skew may be so either from innate or from external causes. In the case of skewness by addition we may think that there is an innate tendency to produce variants of a particular sort, representing, let us say, the *atavistic* individuals. In this case skewness points to the past. The species is evolving *from* the direction of skewness. In the case of skewness by subtraction, there are external causes annihilating some of the individuals lying at one side of the mode. Evolution is clearly occurring away from that side and *in* the direction of skewness.

Now so far as we know at the present time there is no way or distinguishing skew polygons due to atavism from such as are due to selective annihilation. But in many cases at least the skewness, especially when slight, can be shown to be due to atavism; and this is apparently the commoner cause. This conclusion is based first upon a study of races produced experimentally and whose ancestry is known, and secondly upon certain cases of compound curves. Take the case of the ray flowers of the common white daisy. A collection of such daisies gathered in the field and studied by De Vries gave a mode of 13 ray flowers with a positive skewness of 1·2. The 12- or 13-rayed wild plants were selected to breed from, and their descendants, while maintaining a mode at 13, had the increased positive skewness of 1·9. The descendants of the 12-rayed parents had a stronger leaning towards the high ancestral number of ray flowers than the original plants had. The 21-rayed plants were also used to breed from. Their descendants were above the ancestral condition as the descendants of the 12-rayed plants were below. The skewness $-0·13$ is comparatively slight. In this case we have experimental evidence that curves may be skew *toward* the original ancestral condition.

Of the compound polygons it is especially the bimodal polygon that frequently gives hint of two races arising out of one ancestral, intermediate condition. Consequently we should expect the two constituent polygons to be skew in opposite directions; and so we usually find them to be. For example, Bateson has measured the horns of the heads of 343 rhinoceros beetles and has got a bimodal polygon. The polygon with the lower mode has a skewness of +0·48; that with the higher mode a skewness of −0·03. One might infer that the right-hand form, the long-horned beetles, had diverged less than the short-horned from the ancestral condition. Again, as is well-known, the chinch bug occurs in two forms—the long-winged and the short-winged. Now, in a forthcoming paper my pupil, Mr. Garber, will show that the frequency polygon of the short-winged form has a skewness of +0·44, while that of the long-winged form has a skewness of −0·43. On our fundamental hypothesis the ancestral condition must have been midway between the modes.

Still a third class of cases that gives evidence as to the significance of skewness is that where two place modes have moved in the same direction but in different degrees. Thus the index (breadth ÷ length) of the shell of *Littorina littorea*, the shore snail, as measured by Bumpus has, at Newport, a mode of 90; at Casco Bay, of 93. The skewness is positive in both places and greater (+·24) at the more southern point than at Casco Bay (+·13). This indicates that the ancestral races had a higher index even than those of Casco Bay, probably not far from 96, and also that the *Littorina littorea* of our coast came from the northward, since the northern shells are the rounder. We have historical evidence that they did come from the northward. Likewise the Littorinas from South Kincardineshire, Scotland, have a modal index of 88 and a skewness of +0·065, while those of the Humber, with a mode of 91 have a skewness of +0·048. These figures suggest that if the mode were 97 the skewness would be 0, and this would give practically the same value to the ancestral index as arrived at for the Littorinas of our coast. It will be seen from these illustrations that the form of the frequency polygon may be of use in determining phylogeny.

While skewness is thus often reminiscent, we must not forget the possibility that it may be, in certain cases, prophetic. This has come out rather strongly in a piece of work I have been engaged on during the past year. I have been counting the number of rays in recent *Pecten irradians* from various localities, and have obtained in some cases evident skewness in the frequency polygons. To see what phylogenetic meaning, if any, this skewness has I sought to get a series of late fossils. After careful consideration I was led to go to the Nansemond River for the late Tertiary fossils found there and already referred to; these served my purpose admirably. We may now compare the average number of rays from the two extreme layers at Jack's Bank and at Morehead with the indices of skewness of the frequency polygons from the same localities.

Place.	Av. No. of rays.	Index of skewness	σ
Morehead, N.C.	17·3 ...	−0·09 ...	0·81
Upper layer, Jack's Bank ...	21·7 ...	−0·16 ...	1·10
Lower ,, ,, ,, ...	22·6 ...	−0·22 ...	1·24

This series is instructive in that it tells us that the gradual reduction in number of rays has been accompanied at each preceding stage by a negative skewness. This skewness was thus prophetic of what was to be. The skew condition of the frequency polygon we may attribute to a selection taking place at every stage, and the interesting result appears that the selection diminishes in intensity from the earliest stage onward. It is as though perfect adjustment were being acquired. If adjustment were being perfected we might expect a decrease in the variability in the rays at successive periods. And we do find such a decrease. This is indicated in the last column, where σ stands for the index of variability. From this column it appears that the variation in the number of rays has diminished from 1·24 rays in the Miocene to 0·81 ray in recent times. This fact again points to an approach to perfection and stability on the part of the rays. Exactly why or wherein the reduced number of rays is advantageous I shall not pretend to say. It is quite possible that it is not more advantageous, but that there is in the phylogeny of *Pecten irradians* an inherent tendency towards a reduction in the number of multiple parts. As a matter of fact there are other Pectens in which the number of rays is less even than in irradians.

The reduction in the variability of the rays with successive geological periods has another interest in view of the theory of Williams and of Rosa, according to which evolution and differentiation have of necessity been accompanied by a reduction in variability. Evolution consists, indeed, of a splitting off of the extremes of the range of variation, so that in place of species with a wide range of variability we have two or three species each with a slight range of variability. In the particular case in hand, however, it is not certain that the lower Jack's Bank form-unit (named *Pecten eboreus* by someone) has given rise to any other form than something of which *Pecten* "*irradians*" of Morehead is a near representative. The evidence indicates that the reduced variability is solely the effect of the skewing factors.

The upshot of this whole investigation into the biological significance of skew variation is, then, this: Skewness is sometimes reminiscent and sometimes prophetic. In our present state of knowledge it is not possible by inspecting a single skew curve to say which of the two interpretations is correct in the given case. But by a comparison of the frequency curves of allied form-units the state of affairs can usually, as in the examples given, be inferred. A method of interpreting the single skew curve is a discovery for the future.

I realise that I have been bold, not to say rash, in this attempt to forecast the zoology of the twentieth century. I suppose, after all, I have merely expressed my personal ideals. Let those comfort themselves, therefore, who like my picture not and let them draw one more to their taste. These matters of detail are after all less important, but the general trend of the science I believe to be determined by the great general laws that will hold, whatever the detailed lines of development. First, students of the science will cling closer to inductive methods without abandoning deduction. Speculative web-spinning will be less common, will be less attractive, and will be more avoided by naturalists of repute. Great generalisations will be made, of course, but made with caution and founded at every step on facts. Second, the science will deal more with processes and less with static phenomena; more with causes and less with the accumulation of data. The time is coming when the naturalist who merely describes what he sees in his sections will have neither more nor less claim for consideration than he who describes a new variety of animal. It is relations, not facts, that count. Third, the science will become experimental, at least in so far as it deals with processes. Nothing will be taken for granted that can be experimentally tested. Better experimental laboratories will be founded and larger experimental stations, such as Bacon foresaw in the new world, will be established. Fourth, the science will become more quantitative. This is the inexorable law of scientific progress, at least where processes are concerned. I repeat that there is no reason to expect or desire the abandoning of the lines of work already recognised and followed for a half century or more. Rather, holding fast to and extending the old lines of investigation, zoology will be enriched by new fields of study lying between and uniting the old. As chemistry and physics are uniting and occupying the intervening field, as geology and botany are coming close together in plant ecology, so will zoology and mathematics, zoology and geology, zoology and botany find untouched fields between them and common to them. Working in these new fields and by the aid of new methods the naturalist of the future will penetrate further into the nature of processes and unravel their causes.

The zoology of the twentieth century will be what the zoologist of the twentieth century makes it. One hundred years ago the prerequisites of the naturalists were few, and the opportunities of getting them were small. He must have studied with some master or have worked as an assistant under a naturalist in some museum. The places were few, the masters often difficult of approach. Now, while on the one hand the training required is vastly more exacting, on the other hand the opportunities are generous. Just because of the fact that zoology is spreading to and overlapping the adjacent sciences, the zoologist must have his training broadened and lengthened. A zoologist may well be expected to know the modern languages (let us hope this requirement may not be further extended), mathematics through analytics, laboratory methods in organic as well as inorganic chemistry, the use of the ordinary physical instruments, advanced geology and physiography, botany, especially in its ecological, physiological and cytological aspects, and animal palæontology. The list of prerequisites is appallingly long; zoologists of the future will be forced to an earlier and narrower specialisation, while at the same time they must lay a broader foundation for it.

But if the prerequisites of the zoologists are to be numerous, their acquisition will be easy. Even now scores of universities put the services of the best naturalists at the disposal of students, and offer free tuition and living to come and study with them. Libraries, great museums, great teachers are made available to him who would work and had the requisite capacity.

All these advantages will, however, count for nothing if zoological research do not attract the best men and if the best men be not accorded time and means for research. Our best students slip from our grasp to go into other professions or into commerce, because we can offer them no outlook but teaching, administration, and a salary regulated by the law of supply and demand. We must urge without ceasing upon college trustees and corporations the necessity of freedom for research and liberal salaries if America is to contribute her share to the advance of zoology in the twentieth century.

THE CARNEGIE TECHNICAL SCHOOL AT PITTSBURG.

TWO of the addresses delivered by presidents of sections of the American Association for the Advancement of Science at the recent Denver meeting were concerned with scientific and technical education. Mr. J. A. Brashear, Chancellor of the Western University of Pennsylvania, described the plans, drawn up at Mr. A. Carnegie's request, for a great technical college at Pittsburg, and Prof. C. M. Woodward, Dean of the School of Engineering and Architecture, Washington University, St. Louis, took as his text the differences between the educational ideals of to-day and of the time when education was considered merely as needful to the "embellishments of life." The movement towards a study of the materials and forces of Nature and the problem of modern life—sociological, commercial and industrial—has produced a change of front as remarkable as it is gratifying. Out of the vast extension of the horizon of human activities which the movement has promoted, and a corresponding multiplication of occupations, has come an imperative demand for better education and for technically educated men. The scheme for the Carnegie Technical School has been drawn up with the intention of suggesting how to train students to supply this want.

Reference has already been made (July 25, p. 319) to the report of the committee appointed to determine the best plan and most suitable scope of the new institution which Mr. Carnegie is prepared to build, equip and endow in the city of Pittsburg. Further details are given by Mr. Brashear in his address, and are here summarised. After a careful discussion of the plan of procedure, the committee on the plan and scope of the proposed school decided to call to their assistance, as an advisory board, Dr. Robert H. Thurston, Prof. J. B. Johnson, Dr. Thomas Gray and Dr. Victor Alderson, acting president of the Armour Institute of Chicago.

Each member of the advisory board formulated his plans without consultation with other members of the committee, yet it is a matter of interest to know that the expressed views of the advisory board as individual members were so nearly in accord on the general principles formulated for the great school of technology. The following is an outline of the scheme for the new technical school:—

First, as to site. The advisory board suggested that not less than fifty acres be secured, and as a tract of sixty-five acres is available not far distant from the Carnegie Institute, the board strongly recommended its purchase, or a similar piece of land as near by as it is possible to obtain it. A potent reason for placing the technical school near the Carnegie Institute is the fact that its library is rich in technical and other valuable works which need not be duplicated in the technical school library; indeed the association of the school with the great and increasingly valuable library, museum, art gallery and Academy of Science and Art is certainly to be desired.

As to the buildings for the technical school, but little has been suggested. Dr. Thurston in his report has given an interesting *résumé* of the space occupied by the student in the various German technical schools, remarking that the German motto "viel Platz, viel Licht, viel Luft," would be an excellent guide in determining this question. He says: "Ample space, good light and plenty of fresh air are essential, although the architect, who should be the most earnest and intelligent of them all, is often woefully deficient in appreciation of their importance when brain work is going on." Dr. Thurston further states that taking figures from the best German technical schools, which are based on the largest experience, the school of architecture at Berlin has 150 feet floor space per student, the engineering school 35 feet; but this latter department is so much overcrowded that arrangements are being made to give the student in this department at least 75 feet of floor space. In marine engineering 111 feet, and in metallurgy and the chemical departments each have 426 square feet of space. Prof. Thurston advises not less than 30 square feet per student in class rooms, in drawing rooms about 100, and in laboratories from 150 to 500 feet, according to character of the work to be done and magnitude of the space required for machinery and apparatus.

The Brunswick school has 410 feet floor space per student in all departments. At Karlsruhe 450 square feet is provided in the department of electrotechnics. The cost of the Berlin building is placed at 1000 dollars per student, of the Brunswick buildings 2000 dollars per student. From these data it may be seen that an institution which may be called upon to provide for a thousand students at once, and perhaps three or four times that number in the near future, must be planned upon a most liberal scale to meet the demands which shall be made upon it.

As to the scope of the work of the new school, Prof. Johnson's proposed scheme is as follows:—

A. Colleges. Courses of four years with a high school preparation: (1) College of Science; (2) College of Engineering; (3) College of Commerce. All these to be of university grade, with degrees conferred at graduation. B. Schools. Courses of three years with a grammar school preparation: (1) Manual Train School; (2) Domestic Science School; (3) School of Industrial Design; (4) School of Commerce. All these to be of high-school grade. Diplomas to be given at graduation. C. Artisan Day School. Courses of three years, with a preparation in reading, writing and arithmetic. To include courses of instruction in subjects of essential importance in the practice of the various trades. D. Night School for day workers. Preparation same as C. Regular courses, and also special instructions of practical value to day workers of all sorts and all employments.

Prof. Johnson, Dr. Alderson and Dr. Gray studied a number of the industries of Pittsburg, and in all their reports they emphasised the value of the secondary schools. The question of monotechnic or trade schools, *i.e.* where a young man or woman can learn at least the rudiments of a trade by which they propose to make their living, was also discussed; and it is the opinion of both committee and advisory board that in due time this part of the problem should be given earnest consideration.

Dr. Alderson recommended that the six following departments should be established, each with several branches:—(1) Engineering, (2) Secondary Education, (3) Library Economy, (4) Domestic Arts and Sciences, (5) Art, (6) Evening Instruction.

Dr. Gray recommends that the institute should offer a course of instruction covering the whole nine years of study; that it be divided into two distinct schools, a secondary and upper secondary, and a higher college or professional school. He advises that the secondary school commence first above the grade schools with a minimum age limit of fourteen years, and that the course of this instruction should include all the subjects commonly given in the best high schools with the possible exception of Latin and Greek, and in addition the subjects more commonly given in business schools or colleges, along with this course of class-room instruction, provision should be made for practical instruction, either manual or otherwise, bearing upon the particular branch of industry which the scholar intends to enter.

Dr. Gray recommends a good sound course in English for students of the secondary school, but not a study of foreign languages. He also recommends that the technical college or professional school be open only to a selected small number of students who have shown special fitness for the work, and that the entrance requirements should be considerably higher than is usual in existing technical colleges. For this department extensive laboratory practice is recommended and thorough drill in the methods of testing properties of matter and in investigational work.

The general scheme laid out for the great technical university by Dr. Thurston comprises the following colleges:—(1) Mechanical Engineering and the Mechanic Arts, with eight different departments of Mechanical Engineering; (2) Civil Engineering, with six departments; (3) Architecture, with three departments; (4) Mines and Metallurgy, with two departments;

(5) Agriculture, with six departments; (6) Applied Chemistry, with four departments; (7) Physics, with two departments; (8) Fine Arts, with three departments; (9) Business, with four departments; (10) Navigation and Marine Transportation, with two departments; (11) Mathematics, with two departments; (12) Politics and Ecomomics, with four departments; (13) Languages and Literature, with four departments; (14) Philosophical Science and Ethics; (15) Biology; (16) The Preparatory College (standard curriculum).

In his presidental address to the section of social and economical science, Prof. C. M. Woodward referred to the report of the advisory committee on the Carnegie Technical School in the following terms:—"For a variety of excellent reasons the committee reaches the conclusion that some new kind of preparation for the work of life must be introduced into the school training of both boys and girls. It then proceeds to outline a technical college, a technical high school and an artisan day and evening school, which are to meet this demand.

"The artisan day and evening school is somewhat of the order of German and English low-grade technical schools. I earnestly hope that the suggestion of this school may be adopted that the experiment may be fairly tried in America. The plan for a technical college is in complete harmony with the best engineering schools.

"The scheme for a technical high school, however, seems to me faulty. This school would be of high-school grade, taking pupils from the grammar schools and covering presumably four years. The normal ages of entrance and graduation would accordingly be fourteen and eighteen. Three things in the committee's outline of this technical high school deserve attention: (1) The elective principle is to be recognised, the student selecting the required number of courses under the direction of the director of the school. Here the pupil at a tender age (only fourteen or fifteen) is asked to surrender his birthright to the privilege of choice when he is eighteen.

"(2) The course in mathematics—which begins with elementary algebra—is to include the elements of calculus! Of course, it must include solid geometry, higher algebra, trigonometry and analytical geometry! One rarely meets with such an astounding proposition from engineers who are supposed to have studied mathematics and to know what they are talking about. They might as well propose that the pupils shall take thermodynamics in a short course of lectures. To be sure, similar ambitious schemes have been proposed elsewhere for boys just out of the grammar school, but they came from people who could have known very little mathematics, and nothing of the uses of the calculus. This criticism may seem trivial, but in more than one place the scheme attempts too much.

"(3) The technical studies suggested take the form of trade work or special employments, with well equipped shops and experimental laboratories under the direction of expert artisans.

"What Mr. Carnegie will do with this last suggestion remains to be seen, but any attempt to embody it in a real technical high school of secondary grade will be full of interest to the educational world. If any man was well prepared to give the scheme a fair trial, that man is Andrew Carnegie; but it will cost a vast amount of money and its experience will teach us how not to do many things.

"I have high respect for the members of the advisory committee, but I think a less ambitious scheme would be more successful. You cannot teach the higher mathematics in a high school, and I have no great faith in the value of attempts to teach employments, commercial or industrial, within the limits of any secondary school. Such attempts are certain to mislead and ultimately hinder those they aim to help. Any trade or special employment must be dwarfed and narrowed before it can be brought down to the grasp of an untrained boy, and its very narrowness unfits it for the best educational uses.

"The school is the place where one should learn the fundamental unchanging laws and manifestations of force and materials. Special occupations, like special constructions, should be analysed in their elements, and pupils should become expert in such analyses, in so far as they involve universal elements that pupils can comprehend. But there are many things essential to a business employment, which cannot even be apprehended in school."

From the foregoing it will be seen that much difference of opinion exists as to the nature and extent of the subjects which should be included in the curriculum of a large technical school. Three different and distinct forms of school, which may be combined as parts of one complete technical university, have been proposed. If the whole scheme is accepted by Mr. Carnegie, there will be, in the first place, a first-class technical college. "This college," says the committee, "should be made attractive to the greatest scholars in the fields of physical and chemical science. To obtain and hold such men they must be given ample opportunities for research. This college must be supplied, therefore, not only with great experimental shops and laboratories for students' use, but in all departments there should be splendidly equipped laboratories of investigation and research, under the direction of the head of such department, and with a full corps of assistants for the carrying on of all lines of investigation which are now partly or wholly unprovided for in America." There will also be a Technical High School to carry on work above that of the public grammar school, and day and evening classes for the benefit of those who are unable to take advantage of the more complete courses in this school. Mr. Carnegie has now to decide whether he will found a school for artisans, a technical high school or a technical college, or, if his ambition mounts so high, a true technical university including them all.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE building fund of 150,000*l.*, which it is proposed to raise for the Glasgow and West of Scotland Technical College, has reached about 100,000*l.*, and Mr. Carnegie has promised to subscribe one-half the deficiency upon the condition that the other half is promptly obtained.

THE position of science and technical instruction in schools inspected by officers of the Secondary Branch of the Board of Education can be seen in vol. ii. of the Report just issued by the Board, containing extracts from the inspectors' reports for the year 1900. Improvement is manifest in the larger technical schools in the teaching of advanced science. General improvement is also reported in the mode of teaching experimental science. "Moreover," remarks Mr. A. E. Tutton, F.R.S., "the influence of the advocates of the heuristic method of teaching has proved to be so far effective that the general attention of teachers has been directed to the educative value of calling forth the highest thinking and experimenting powers of their pupils." Dr. H. H. Hoffert also reports that "there is amongst the teachers a widely spread spirit of enthusiastic eagerness to ascertain the best methods of instruction and to apply them in their own schools." The movement for reform is being felt in the teaching of mathematics, and Mr. J. Brill contributes a short special report upon the subject to the volume just issued. The work being done in the Schools of Science is favourably reported upon by all the inspectors. In these schools five or six hours a week are given to experimental science, two or three to drawing and geometry, about five to mathematics, and eight or ten to literary subjects. Beyond this minimum requirement the extra time at the disposal of the school is given to languages, to science, to commercial subjects, or to manual occupations according to the particular type of the school. In fact, these schools possess a curriculum which is adapted to modern requirements, and in most of them excellent work is being done, not only in science and art, but also in literary subjects.

A FULL report of the opening of the Harper-Adams Agricultural College at Edgmond, Newport, by Mr. Hanbury, the President of the Board of Agriculture, appears in the *Newport and Market Drayton Advertiser* of September 28. The College owes its establishment to the late Mr. Thomas Harper-Adams, who left a large sum of money and an estate in order to found it. It is provided with lecture rooms and laboratories in which work can be carried on in physics, chemistry, biology, and other sciences connected with agriculture. The farm attached to the College is about 180 acres in extent and is intended for experimental purposes; and all the work will be arranged with the object of instructing students in the practical management of a farm on modern business lines. The Salop County Council make a grant of 1000*l.* a year towards the College funds, and together with the Stafford County Council offer a certain number of scholarships tenable at the College. The Principal is Mr. P. Hedworth Foulkes. In opening the College, Mr. Hanbury referred to the small sum available for agricultural education. At present the Board of Agriculture had to spend, in grants, the small sum of 8000*l.* for the whole of the United Kingdom. In France, for the same purpose, 153,000*l.*

is granted by the State. In Denmark, 108,000*l.* is granted; in Canada, 156,000*l.*; and in the United States, 26,000*l.* Moreover, a comparison of the assistance given to agriculture with that given to the towns shows that out of the Science and Art grants given by the Board of Education, no less than 505*l.* out of 506*l.* goes to the towns, and only 1*l.* to the rural population. Referring to the value of agricultural colleges and scientific work to the practical farmer, Mr. Hanbury remarked that it was sometimes asked, What is the good of science? He took science to mean this, however practical a man might be, it was impossible for him, in his own experience, to have learned everything. What science meant was, that other people had been experimenting, and had found that those experiments had been a success, and that it made money to work in that way. He therefore asked them not to be afraid of the word "science"; and, above all, not to think, because they were practical men, that they knew everything, for there was no trade in the world in which there was any man who had occupied the whole region of science, or the whole region of knowledge. He thought they made a mistake in making experiments over and over again. He was a little afraid the County Councils, in too many instances, were going over the same ground over and over again. What was to be of some use to farmers was that those experiments had been made, and the results proved to be true. He should like to see more demonstrations made all over the country—not mere pocket handkerchief demonstrations over a small field, but, if they were to be any good, over several fields of a farm.

SCIENTIFIC SERIAL.

American Journal of Mathematics, vol. xxiii. No. 4.—Memoir on the algebra of symbolic logic is the second part of a paper by Mr. A. N. Whitehead, which treats of the theory of substitutions under the heads, types of transformation, relations between the coefficients of a substitution, the reverse substitution, the group of substitutions, substitutions satisfying special conditions, congruence of functions, the identical group of a function, and common subgroups of identical groups.—Secular perturbations of the planets, by G. W. Hill, follows up Halphen's presentation of Gauss' procedure (*Werke*, vol. iii. pp. 331–355). The author thinks that, though a remarkable degree of elegance is attained by Halphen's changes, additional statements are needed to show the connection with the astronomical problem which originally suggested the investigation; for Halphen, like Gauss, treats only the attraction of a certain form of ring. This ignores the second integration which the problem demands. The present memoir attempts to supply the lacuna.—Representation of linear groups as transitive substitution groups, by L. E. Dickson, is a piece of work on the well-known lines of this mathematician.—A class of number-systems in six units, by G. P. Starkweather, is a further contribution to the same subject which was treated of by the author in vol. xxi. No. 4.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 16.—M. Bouquet de la Grye in the chair.—Demonstration and use of the formulæ relating to the refractometer, by M. A. Cornu.—On the elastic arch, by M. G. Poisson.—On the simultaneous employment of multiplex and ordinary telegraphy in the same circuit, by M. E. Mercadier.—On the molecular weight of chloral hydrate at the temperature of its boiling point, by M. de Forcrand. By a discussion of thermochemical data the author arrives at the conclusion that at the boiling point chloral hydrate is not totally dissociated, from 4 to 5 per cent. remaining undissociated.—On dunite from Koswinsky-Kamen, in the Ural, by MM. K. Duparc and F. Pearce. The results of a microscopical and chemical study of the dunites from this district.—A new cave with drawings on its walls of the Palæolithic period, by MM. L. Capitan and H. Breuil. An account of the discovery of a cave situated at Combarelles, in Tayac (Dordogne), about two kilometres from the Mouthe cave. The cave is about 225 metres long, and about 119 metres from the entrance drawings can be seen on the walls, which continue to the end of the cave. They are engraved upon a cretaceous rock, but the greater number are covered with a stalagmitic deposit, which is sometimes so thick that the lines cannot be seen through it. No less than 109 figures can be clearly made out, including drawings of the horse, cow, bison, reindeer, mammoth, and wild goat. It would appear that these drawings, the antiquity of which cannot be doubted, could only have been executed by artists reproducing animals that they saw. Hence they are clearly Palæolithic, and go back to the epoch when the mammoth and the reindeer lived in France.—Luminous rays diverging at 180° from the sun, by M. Jean Mascart.

September 23.—Binary systems and couples of kinematic elements, by M. G. Kœnigs.—Lecithin in tuberculosis, by MM. H. Claude and A. Zaky. Experiments on animals and on man showed that lecithin, owing to its specific action on the elimination of phosphates by the urine, has a remarkable action on the nutritive exchanges, and it must be considered as a valuable adjunct to the various modes of treatment of tuberculosis.—On the ravages of the pyralis in the Beaujolais, and on the destruction of the night moths by means of luminous traps fed with acetylene, by MM. G. Gastine and V. Vermorel. The traps consisted of basins containing water covered with a layer of oil, above the centre of which was placed a small acetylene lamp to attract the insects. By this method between August 13 and 31 no less than 170,000 pyrales were destroyed.—The distribution of acidity in the stem, leaf, and flower, by M. A. Astruc. The acidity of the stem diminishes with the distance from the top. In the case of the leaves the acidity is greatest in the youngest leaves, and in general it is always the youngest parts of the plant which present the maximum acidity.—A new cave with figures on its walls of the Palæolithic period, by MM. L. Capitan and H. Breuil. A description of the drawings on walls of a cave at Font-de-Gaume, situated in the valley of the Beune, about two kilometres from the cave of Combarelles. The drawings consist largely of animals, of species resembling those represented in the cave of Combarelles. These drawings are noteworthy for the fact that different colours have been used, black, red, and brown. They are probably not so ancient as the drawings on the walls of the cave at Combarelles.

NEW SOUTH WALES.

Royal Society, August 7.—Prof. T. W. Edgeworth David, F.R.S., vice-president, in the chair.—Notes on some analyses of air from coal mines, by A. A. Atkinson and F. B. Guthrie. The authors gave the analyses of several samples of air from the return air-ways at Wallsend and Burwood collieries, and of gases produced by fires in the Gunnedah and Greta collieries, the latter was an old gob. fire. The analyses were compared with published analyses of air in the return-ways of English collieries made by Dr. Haldane, and the question of the effects of diminution of oxygen, presence of carbonic acid, black-damp and other injurious gases found in the air of coal-mines, discussed in relation to their action on men and lights.—Symmetrically distorted crystals of Cassiterite from Western Australia, by W. G. Woolnough.

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THURSDAY, OCTOBER 10, 1901.

RATIONAL GEOMETRY.

Plane and Solid Geometry. By Arthur Schultze, Ph.D., and F. L. Sevenoak, A.M., M.D. Pp. ix+370. (New York: The Macmillan Company, 1901. London: Macmillan and Co., Ltd.) Price 6*s.*

THIS is an excellent work for all young students who wish to begin the study of geometry. In its order of treatment it completely ignores Euclid, and thus saves the young pupil from a long and wearisome waste of time, giving him clearly and rapidly a knowledge of the subject and an insight into its nature and purpose. We wish that the English schoolboy could congratulate himself on its appearance; but this is forbidden by our conservatism and the attachment of our public and preparatory schools to mediævalism. When an Educational Reformation takes place in England—and there are signs of its advent—such a work will be welcomed by all of us who are interested in the scientific education of the people.

The book is divided into two parts—Plane Geometry and Solid Geometry. The first part is divided into five books (225 pages), and the second into three (93 pages). The type is excellent, and the figures (especially those in the second part) beautiful.

To enter now into a few matters of detail, we would suggest to the authors that they should not have followed the English plan of beginning with a catalogue of fifty definitions before the pupil reaches the real work of the subject: this makes for tediousness. The term *straight angle* (adopted, apparently, from the A.I.G.T.) is, we think, very objectionable, because the notion of straightness should be kept quite distinct from that of an angle. The first proposition in the book, "vertical angles are equal," is Euclid's 15th; prop. 2 is Euclid's 26th; prop. 3 is Euclid's 4th; prop. 4 is Euclid's 16th. Thus a common-sense order of treatment is freely adopted. Then comes the treatment of parallel lines in which all of Euclid's results are given. The definitions of degrees, minutes, and seconds are given in the preliminary definitions (p. 5), but the protractor is not mentioned, so that the actual way of reading the value of a given angle is not exhibited. This omission of the protractor seems to us to be a mistake. Some propositions are merely enunciated, and, instead of a formal proof, a "hint" to the pupil in a few words is given. This is good, because it exercises, without severity, the power of the young thinker. The famous Asses' Bridge is given as prop. 14, with the mere hint that it would be obvious if the bisector of the angle at the vertex were drawn—as, of course, it would be. Herein observe the contrast to Euclid, who would not allow us to use this bisector unless he had previously shown how to construct it—a perfectly useless restriction which runs through the whole of Euclid. Of course it is subsequently shown (p. 35) how to bisect an angle and a line. The authors are generally precise in their use of language, without adopting the grotesque show of accuracy in our school Euclids. Nevertheless, they occasionally make an absurd use of the word *respectively*, which is so prominent in these works. Thus (p. 30), "two triangles are equal if the three sides of the one are respectively equal to the three sides of the other"; clearly no *order* of equality is necessary. See also end of p. 74.

In p. 33 and elsewhere the authors boldly define a circle as an area, and distinguish it from its bounding curve, which they call "a circumference." If we punch a wad out of a sheet of cardboard, which area has the right to be called the circle—the wad or the whole of the outside area of the sheet?

In this respect, however, the authors are consistent, while Euclid is not. Euclid's formal definition makes the circle an area, while in his Book III. he says that two circles cannot have more than two points in common.

The English barbarism involved in the proposition "if two sides of a triangle are equal, the opposite angles shall be equal," is consistently avoided, the simple word "is" or "are" being always used instead of the compulsory and ridiculous "shall be" of our school Euclids.

The second book of Part i. treats of the circle, and travels over the ground of Euclid's III. and a little more, arithmetical examples being occasionally given—a great desideratum in our English system. Here measurement and ratio are introduced, as well as the notion of limits—a great improvement. Euclid's first book problem, "to construct a triangle when its three sides are given," appears here as prop. 19—a postponement of more than doubtful value.

The third book is on proportion and similar polygons, and the propositions are illustrated and explained by simple algebra and arithmetic; thus the beginner can learn the essence of the subject in a few minutes without wasting a lifetime on Euclid's Book V. In this book the authors give the propositions relating to the equality of areas, of triangles, and parallelograms, while the proposition of Pythagoras now appears for the first time (p. 147), founded on the similarity of the two triangles into which a "right triangle" is divided by the perpendicular from the vertex on the hypothenuse; the old proof and time-honoured figure are, however, given in the next book (p. 178). Near the end of the third book we have Euclid's well-known proposition whose trigonometrical form is $c^2 = a^2 + b^2 - 2ab \cos C$, the proof being, of course, geometrical, but presented in algebraic form.

The fourth book treats of the areas of polygons, and the proofs are presented in algebraic form. The exercises all through are numerous and very appropriately placed.

In the part dealing with solid geometry and the fundamental properties of spherical triangles, the figures are, as we have said, exceedingly good and realistic.

In p. 264 we have the proposition "the sum of any two face angles of a triedral angle is greater than the third face angle"; but the proof will have to be slightly modified, as, in its present form, it is confusing for the beginner. Thus, to the words "in the face AVC draw VD equal to VB, making $\angle$ DVA = $\angle$ BVA," it may fairly be objected that this is impossible if the points A and C are already given. The line VD should first be drawn, and then the lines ADC and BC. Again, in

p. 205, the proposition "the circumference of a circle is less than the perimeter of any enveloping line" has no special reference to a circle—it is true of any oval figure whatever, and no special property of the circle is employed in the proof. We think that it should be struck out as misleading. Finally, we must point out that the Socratic method of teaching the pupil by a system of questioning—the most efficient of all teaching methods —is adopted throughout the book. The limited space at our disposal has not by any means allowed of such an exhaustive exhibition of its merits as this work deserves. GEORGE M. MINCHIN.

NATIVE LIFE IN SOUTHERN INDIA.

Occasional Essays on Native South Indian Life. By Stanley P. Rice, Indian Civil Service. Pp. vi + 223. (London: Longmans, Green and Co., 1901.) Price 10*s.* 6*d.* net.

THESE sketches of south Indian life are concerned, not with any of the districts, like Madura or Tanjore, in the extreme south of the peninsula, but with Ganjam, which while politically connected with the Madras Presidency, is by the race, language, and customs of its people more closely linked with the Bengal Province of Orissa. This political separation from his northern kinsfolk has worked evil to the Uriya of Ganjam. The ordinary Madrasi looks on him as an inferior creature, "not merely low in the rank of civilisation, but incapable of better things"; and he is carefully excluded from the official employment which is monopolised by his Telegu neighbours in the south. Hence, as might have been expected, he has no ambition to develop his own language or literature, and he remains a boor, slovenly in his mode of life, and with little love for the foreign native officials who manage his affairs. But he is not quite destitute of good qualities. He is a hard-working farmer; he is not given to drink, like the Telegu; and Mr. Rice vouches for the fact that, when addressed in his own tongue by one who understands and appreciates him, he is courteous and hospitable. But still there is a vein of savagery beneath his boorish exterior, as is shown by the graphic account given by Mr. Rice of the so-called Rebellion of Parlakimedi, which plunged the land in ruin and anarchy during the early years of last century. As usual in such cases, it arose from the apathy and ignorance of the early officials; and it was not till many years had passed in maladministration that a strong man was found at last in Mr. George Russell, one of those little-known heroes of our Indian services, who gave the land peace which has never since been disturbed.

Mr. Rice, though a careful and sympathetic observer of native life, seems to have little knowledge of Indian anthropology and folklore. This is perhaps not an unmixed disadvantage. He does not come, like some of our Indian officials, ready to apply book learning to the study of savage life; nor is he primed with that modicum of acquaintance with comparative anthropology which leads him to see a totem in every bush, or a tree-god in all rural ceremonies. But had he possessed a wider acquaintance with some of the problems which anthropology attempts to solve, his studies could have hardly failed to gain in precision and interest.

We have in Ganjam an excellent example of three overlapping races. The Uriya of the plain country is a Dravidian with a certain amount of Aryan intermixture. His language is not "a blend of Sanskrit and Hindustani," but a form of Bengali affected by the Telegu or other South Indian tongues. A wider study of linguistics would make it clear to Mr. Rice that the word Ponda for a priest, which puzzles him, is merely the Sanskrit *panda*, "a learned man."

Next on the lower hills come the Khonds or Khânds, who seem here to have preserved no tradition of the Meriya sacrifice through which they are best known to ethnologists. They are a race of half savages already half ruined by the trickery of the Uriya Shylock, and deprived of their old mode of livelihood in the jungles by the repressive rules of the Forest Department.

Still further back in the more remote hills are the Savaras or Sauras, who enjoy a free savage life, periodically burning down the jungle to sow their scanty crops, but living mainly on the fruits and roots which the forest supplies. But they possess some traditions of a more settled life, because it is their law that the dead man must be cremated with the wood of the mango, and this must be done "in the portion of ground—one cannot call it a field—which he last occupied." Of course this may be a sign of Hindu influence, but Mr. Rice does not say so, and Mr. Risley's account of the race in Bengal does not support the suggestion.

Of the marriage rites of these jungle people Mr. Rice gives some interesting details, but he misses the point of some of their practices because he has not grasped the fact that they indicate a reaction against the early custom of "Beena" marriage, in which the bridegroom is adopted into the clan of his wife. This still prevails among the Savaras, where if the bride's father agrees to the alliance, "he and the bridegroom elect to go into partnership and cultivate for two or three years."

The religion of these races is, as usual, of the animistic type, but it has been largely influenced by the Orissa cult of Jaggannâth. Witchcraft, of course, and the custom of rendering the witch harmless by knocking out the teeth, prevail widely. Special respect, which may be totemistic, but is more probably the survival of some animal cult, is paid to the bear, "as they have a curious fancy that the souls of their ancestors inhabit the bodies of bears after leaving their human prison." Mr. Rice has never been able to discover why, when building a house, they plough up the site and sow some grain after consulting a priest or seer. This is a common form of mimetic magic, performed with a view to ensure the prosperity of the household.

We trust that if Mr. Rice has the good fortune to be again posted to such an interesting district as Ganjam he will continue his studies among those wild races about whom he displays such a sympathetic interest. But he would come better prepared for such inquiries if he mastered Mr. Risley's account of the tribes of Bengal and other equally accessible works on Indian ethnology and folklore.

THEORETICAL EXPLANATIONS OF GEOLOGICAL FACTS.

Essai d'une Explication par les Causes actuelles de la Partie théorique de la Géologie. Par H. Hermite. Pp. 115. (Neuchâtel: Attinger, 1901.)

M. HERMITE believes that the facts of geology admit of much simpler theoretical explanations than they have hitherto received. Whether his substitutes will be generally adopted is, we think, open to question; but as it would be a lengthy business to criticise them in detail we must restrict ourselves to a brief outline of their leading features. Mountain-making is not, as is generally thought, the result of a cooling of the liquid earth's interior, for that is not in accord with the theory of heat. It is caused thus:—The crust is very flexible. Materials deposited upon it produce a downward movement in that part with a corresponding upward one in another, so the ocean basins are constantly sinking and the continents rising. This upward movement is concentrated on the periphery of the basins, where the strata are bent, strained, and finally fractured. Motion is converted into heat and the temperature of this zone is elevated. It then communicates heat to the adjacent ocean, and thus increases evaporation. That results in a heavier rainfall. The precipitated water works down into the rising land, thus cooling it, and producing of course the greatest effect nearest to the surface. So the rise of temperature observed in sinking wells, &c., is due to a local cooling rather than to the cause usually assigned. That the consequence of mountain-making is abundant rain is proved by the prevalence of sandy deposits in the earliest geological ages. Another consequence is that periods of extensive and rapid deposit of detritus are succeeded by others of slow and regular sedimentation. M. Hermite passes on to explain the occurrence of the warm era with which the earth's history began, and the glacial epoch of its later days. Crust cohesion, he says, was great in early times, so more material was needed to make it sink; and thus the rise of temperature of the basins was greater. Evaporation was thereby increased and the whole surface covered with a veil of mist, resulting in a mild, uniform climate. But the heavy rains penetrating into the crust ultimately chilled it, and the streams which they produced cooled the ocean, till things returned to their former condition. As the cohesion afterwards became gradually less, this universal, warm, damp atmosphere did not recur, and the loss of heat by radiation gave rise to the seasons. But earth movements were augmented about the time of the passage of the Tertiary into the Quaternary, and led to precipitation which supplied the snow for the great glaciers. Thus this epoch was brought to an end rather by the diminished warmth of the ocean waters than by a rise of the general air temperature. At the present day the great glaciers of the Polar regions are largely fed by the water emitted from volcanoes. The Carboniferous period seems to have been a turning point in the history of the globe; for the crust up to that time was less fissured, and so was not chilled by the penetrating water; hence the high temperature of the seas kept the carbonic acid in the atmosphere. But after that became fixed in the form of coal the present conditions became possible. M. Hermite, we think, is not likely to get his theory adopted by geologists until he shows in more detail that it will harmonise with the facts; for he usually contents himself with vague statements, which read like his impressions of books. Also, when he plays havoc with the names of fossils (*e.g.*, *Rhinocéros*, *Thycorinus*, for *R. Tichorhinus*), and attributes the cirques and gorges of mountain regions, with the cañons of more level districts, to the action of subterranean water, we feel that he is making a possible exception a general rule, and we cannot help doubting whether he has any practical knowledge of the science. In fact, much of his geology seems on a par with his statement (p. 29) that the volume of a series of spherical shells increases as the cube of their radii.

OUR BOOK SHELF.

La Géologie. Par H. Guède. (Bibliothèque des Sciences Contemporaines.) Pp. 724. 151 figures intercalées dans le texte. (Paris: Schleicher Frères, 1901.)

IN his very modest preface, the author of this volume disclaims any idea of adding to the accumulated mass of geological facts or of advancing new theories to account for them. His object is to present, in a lucid manner, a summary of acknowledged facts and generally received theories, following the encyclopædic treatise of M. de Lapparent, and to do so in such a way as to make the subject of interest to the general reader, while avoiding the claptrap style of certain so-called popular works.

In a task of this kind there is not much opportunity for originality of treatment, and the author wisely follows the general plan of geological treatises in discussing first the causes at present in operation in the earth's crust, secondly the changes in the earth's surface features, thirdly the internal forces at work within the earth's crust, and fourthly the evolution of the earth. In his classification of the geological periods, the author follows most French writers in treating the Quaternary era as the equivalent of the Tertiary, Secondary and Primary eras, a plan which is not without inconvenience to the student. The illustrations of the book appear to be all original, and are of a very simple character—indeed, nothing more than transcripts of such rough sketches as a teacher would draw upon the blackboard. While this plan has the advantage of enabling the teacher to emphasise the *essential* features in the sections and fossils he refers to—and these are often missed in more elaborate picture-illustrations—it is in some cases manifestly inadequate for teaching purposes. Thus the reader of this work would have no idea of the characters of the rocks described when seen in thin sections under the microscope. On the whole, however, the author may be congratulated on having produced, within a very moderate compass, a clear and exact exposition of geological science.

Farm Poultry. By G. C. Watson. Pp. x + 341. Illustrated. (New York: The Macmillan Company, 1901; London: Macmillan and Co., Ltd.) Price 5*s*. net.

THIS popular sketch of poultry farming is a very useful addition to the Rural Science Series. Mr. Watson has written for practical men, and gives working details on every part of his subject, but he has at the same time written in a really scientific spirit. Scientific terms are, indeed, entirely avoided; the language is clear and simple; but the principles which underlie good practice are in every case brought to the front, so that a rational acquaintance with the subject is ensured. There is, perhaps, no department of farming which suffers so much from mismanagement as the poultry yard, yet the industry is of national importance. Mr. Watson reminds his readers that the annual value of farm poultry and eggs produced in the United States, according to the census returns of 1890, exceeded the annual value of the coal, iron, and mineral oil produced during the same period. In England we have no such statistics, but the Trade and Navigation Returns show that the imports of poultry and eggs to this country amounted last year to the value of 6,416,468*l*. The book has numerous illustrations.

R. W.

The Collected Scientific Papers of John Couch Adams. Vol. ii. Pp. xxxii+646. (Cambridge University Press, 1900.)

THE astronomical papers in this volume have been ably edited by Prof. Sampson. The first eighteen papers form a connected series on the lunar theory, and are substantially the lectures on that subject which Adams used to deliver at Cambridge. As an aid to the student they probably surpass any text-book that has been written on the subject. It has been said that the difficulties of the lunar theory begin where the text-books usually leave off, but Adams introduces the reader to many of the practical difficulties of the numerical work, such as the slow convergence and small denominators.

The other astronomical papers are miscellaneous in character and must have taxed the editor to the utmost, for, to quote the preface, "the papers . . . were almost devoid of arrangement. . . . It would have been a hopeless task . . . had not almost every page been dated. This permitted reference to a diary. . . ." Among the most interesting papers are those on Jupiter's satellites, a subject which Prof. Sampson has made his own, a paper on an infinite determinant in the motion of the moon's node which shows that Adams came nearer than anyone else to anticipating Hill in his treatment of the lunar theory, and some papers on the moon's secular acceleration.

The second and larger half of the volume is devoted to Adams' papers on terrestrial magnetism edited by his brother, Prof. W. C. Adams. These consist chiefly in a determination of the Gaussian magnetic constants, a problem for which the material is even now scanty, owing to the fact that such magnetic observatories as there are, are for the most part closely grouped together in one portion of the earth's surface.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Rolling Angle of a Ship found by Photography.

WHILE crossing the Pacific Ocean between Auckland, N.Z., and Sydney, N.S.W., in the Union s.s. *Mokoia*, I wished to determine, if possible, the rolling angle of the ship by some means, other than that of the inclinometer, which the captain allowed me to inspect from time to time. As the period of rolling was long, it seemed quite possible that an ordinary kodak camera might be manipulated and a fresh film introduced, between the end of the roll to port and then to starboard. This turned out to be the case: the results are shown in the pictures A and B, which indicate the inclination of the ship to the horizon, to starboard and to port, respectively. The films when developed and finished were superposed, so that the pictures of the ship in each photograph coincided. The print made from this combination of the pictures B and A gives the composite picture C, in which the horizon in picture A is separated from that in picture B by the angle shown, which when measured with a circular protractor was found to be 19° 6′. After a few trials, no difficulty was experienced in making the exposure at the right time, viz., at the ends of a roll. Better results might have been obtained on dry plates, as films do not stand high temperatures well. The film B is very slightly distorted. The angle may also be found by means of a single picture; in this case a small stop should be used, and the exposure made for a longer period than that of one roll; the angle then appears as a rather faint fan, but the definition at the ends of the roll is not so well defined as when two pictures are made and then superposed.

A B C

Union Steamship Co.'s *Mokoia*. Rolling angle found by photography. A is a picture taken at the instant of the end of rolling to the right, S: B is a picture taken at the instant of the end of rolling to the left, P; C is a composite picture made by superposing the two films, A and B. The pictures of the ship are made to coincide, thus the angle between the two horizons in A and B is found. Lat. 34° 27′ S. Long. 157° 43′ E. To Sydney 325 miles.

Since my return to England, I find that M. Huet, of the French Navy, used a photographic method for indicating the rolling angle. But as his work on the subject is only in the hands of the French Naval Department, it cannot be consulted. His method is referred to in Sir W. White's "Manual of Naval Architecture." After obtaining the results shown in picture C, I devised an apparatus whereby the inclinometer angle may be simultaneously compared with that found by the photographic method. By this means, the positions of the inclinometer are also recorded on the films on which the horizon appears, so that the angle shown by the inclinometer may be at once compared with the angle found by the photographic method, which is entirely free from the errors inherent in pendulum inclinometers.

F. J. JERVIS-SMITH.

British Instruments at the Paris Exhibition.

IN connection with the English exhibits at the Paris Exhibition last year, it may be worth while to quote the concluding paragraph of this part of the impartial and very carefully considered report of Prof. Dufour, of Lausanne, the Swiss member of the jury.

"L'Angleterre vit, dans le domaine des instruments scientifiques, dans un isolement assez grand par rapport aux autres pays. Elle a ses habitudes et ses traditions, des instruments bien faits, mais ces constructeurs, ne paraissant guère se soucier de ce qui se fait hors de chez eux, ont peu d'influence sur l'étranger."

C. V. BOYS.

Notes on Minerals from the Lengenbach Binnenthal.

IN a recent visit to Binn I obtained some interesting minerals —viz. (1) a new mineral (2) Dufrenoysite, (3) Hyalophane.

(1) A new member of the sulpharsenites of lead, crystallising in the oblique system

$$\beta = 82^\circ 42\tfrac{2}{3}'. \quad a:b:c = 1{\cdot}36817 : 1 : {\cdot}947163.$$

Very similar to dufrenoysite in appearance, but distinguished by the rounding of the dome and pyramid planes and well-marked oblique symmetry.

I found an imperfect crystal three years ago, but it was not till last August that I obtained sufficient material to fully determine this new mineral.

(2) I also found some very finely developed crystals of dufrenoysite having fifteen new faces, also a twinned crystal, twin plane (0.1.14), thus resembling rathite, whose twin plane is (0.15.1).

(3) Hyalophane, the baryta felspar which is isomorphous with orthoclase, is now shown by some of my specimens to twin according to the Baveno and Manebach laws of twinning in orthoclase.

A full account of the above will appear in the next number of the *Mineralogical Journal*. R. H. SOLLY.

Cambridge.

Gog and Magog.

YOUR interesting paragraph in NATURE of September 26 on the local Flemish giants carried annually in procession omitted the parallel most suggestive to English readers: Gog and Magog, cousins German of Gayant and Phinar, used also to figure annually in the Lord Mayor's Show, as is noted in Chambers's Encyclopædia. According to tradition "the Guildhall giants are images of the last two survivors of a race of giants who inhabited Albion, descendants of wicked demons and the thirty-three infamous daughters of the Emperor Diocletian, who, after murdering all their husbands, sailed to Albion. These giants Brute and his Trojans finally overcame, leading the last two survivors prisoners to London, where they were kept as porters at the palace-gate. This is Caxton's account; another represents one of the giants as Gogmagog, and the other as a British giant who killed him, named Corineus. These giants have stood in London since the days of Henry V., and have witnessed all its history since. The old giants were burned in the great fire, and the new ones, which are 14 feet high, were constructed in 1708. The ancient effigies, which were made of wicker-work and pasteboard, were carried through the streets in the Lord Mayor's Shows, and copies of the present giants were in the show of 1837. Formerly other towns in England and abroad had their giants, as the Antigonus of Antwerp, 40 feet in height, and Gayant, the giant of Douay, 22 feet in height." D. P.

Edinburgh, October 3.

Fireball of September 14.

A VERY memorable meteor fell into the Atlantic on September 14, 1492, and is recorded in the diary of Columbus. It would be interesting to know whether his notes are sufficiently precise to enable one to say whether the radiant of that meteor is the same as that of more recent ones. C. E. STROMEYER.

Lancefield, West Didsbury.

A New Name for an Ungulate.

IN a paper published in the *Geological Magazine* for September 1901 I described a large ungulate from the Eocene of the Fayûm, Egypt, under the name *Bradytherium grave*. I now find that the name *Bradytherium* had been employed a few months previously by G. Grandidier for a large extinct edentate from Madagascar (*Bull. Mus. d'Hist. Nat.*, Paris, 1901, p. 54), and I therefore wish to propose the name *Barytherium* for my genus. CHAS. W. ANDREWS.

British Museum (Natural History), October 7.

ON THE MAGNETIC ROTATION OF LIGHT AND THE SECOND LAW OF THERMODYNAMICS.

IN a paper published sixteen years ago I drew attention to a peculiarity of the magnetic rotation of the plane of polarisation arising from the circumstance that the rotation is in the same absolute direction whichever way the light may be travelling. "A consequence remarkable from the theoretical point of view is the possibility of an arrangement by which the otherwise general optical law of reciprocity shall be violated. Consider, for example, a column of diamagnetic medium exposed to such a force that the rotation is 45°, and situated between two Nicols whose principal planes are inclined to one another at 45°. Under these circumstances light passing one way is completely stopped by the second Nicol, but light passing the other way is completely transmitted. A source of light at one point A would thus be visible at a second point B, when a source at B would be invisible at A; a state of things *at first sight*[1] inconsistent with the second law of thermodynamics." (*Phil. Trans.* 176, p. 343, 1885; *Scientific Papers*, vol. ii. p. 360). It is here implied that the inconsistency is apparent only, but I did not discuss it further.

In his excellent report ("Les Lois théoriques du Rayonnement, Rapports présentés au Congrès International de Physique," Paris, 1900, vol. ii. p. 29), W. Wien, considering the same experimental combination of Nicols and magnetised dielectric, arrives at a contrary conclusion. It may be well to quote his statement of the case. "La rotation magnétique du plan de polarisation constitue un cas exceptionnel digne de remarque, et l'on pourrait ici imaginer un dispositif qui mettrait en échec principe de Carnot s'il n'existait pas une compensation inconnue.

"Faisons, en effet, les suppositions suivantes; Deux corps de température égale sont entourés d'une enveloppe adiabatique. Les rayons qu'ils s'envoient réciproquement traversent deux prismes de nicol. Entre ces prismes se trouve une substance non absorbante sur laquelle agissent des forces magnétiques qui font tourner le plan de polarisation d'un angle déterminé. La radiation émanant du corps 1 pénètre dans le nicol 1. Nous supposerons que le rayon subissant la réflexion totale n'est pas absorbé, mais renvoyé dans sa propre direction par des miroirs convenablement disposés. Admettons que le plan de polarisation soit tourné de 45° par les forces magnétiques. La section principale du deuxième nicol étant orientée dans la direction parallèle au plan de polarisation du rayon émergent, toute la lumière transmise par la substance absorbante (*sic.*) traversera le nicol. Par consequent, la moitié des rayons émis par le corps 1 frappera le corps 2.

"Les rayons émis par le corps 2 se divisent en deux parties égales, dans le nicol 2. Une moitié est, comme précédemment, renvoyée par réflexion. L'autre moitié, après que son plan de polarisation a subi une rotation de 45° dans le même sens que le rayons émis par le corps 1, vient frapper le premier nicol. La section principale de ce nicol étant perpendiculaire au plan de polarisation, aucune radiation ne le traverse, et nous pouvons renvoyer toute la lumière au corps 2.

"Le corps 2 recoit ainsi trois fois plus d'énergie que le corps 1. [That is, 2 receives the whole of its own radiation and the half of that of 1, while 1 receives only the half of its own radiation.] L'un de ces corps s'échauffera par conséquent de plus en plus aux dépens de l'autre."

Wien then suggests certain ways of escape from this conclusion, but it appears to me that the difficulty itself depends upon an oversight. It is *not* possible to send back to 2 the whole of its radiation in the manner

[1] The italics are in the original. That magnetic rotation may interfere with the law of reciprocity had already been suggested by Helmholtz.

proposed. The second half, which after passage of Nicol 2 is totally reflected at Nicol 1 and then returned upon its course, on its arrival at Nicol 2 is not transmitted (as Wien seems to suppose) but is totally reflected. When again returned upon its course by a perpendicular reflector, and again rotated through 45° by the magnetised medium, it is in a condition to be completely transmitted by Nicol 1, and thus finds its way to body 1, and not to body 2 as the argument requires. The two bodies receive altogether the *same* amount of radiation, and there is therefore no tendency to a change of temperature.

Although I have not been able to find any note of it, I feel assured that the above reasoning was present to my mind when I wrote the passage already cited.

RAYLEIGH.

MARTIN F. WOODWARD.

IN Martin Fountain Woodward, whose untimely death by drowning we recorded in our issue of September 26, science has lost an untiring devotee, zoology a brilliant student and investigator, a teacher whose personal influence and example will live in the memory of those to whom he so willingly imparted knowledge.

M. F. Woodward, younger son of Dr. H. Woodward, F.R.S., keeper of the geological department of the British Museum of Natural History, was born in London on November 5, 1865, and educated at Kensington Grammar School. In 1883 he entered the Royal School of Mines and Normal School of Science as an associate student, qualifying in 1885 with distinction, as the recipient of the Murchison medal and prize of books, for excellence in geology. In zoology he attended the last session's work conducted by the late Prof. Huxley. In both elementary and advanced examinations he headed the pass-list, and showed his power by an achievement in the practical work which so far excelled all precedent that for years his dissection was at Huxley's request kept for use, as an ideal to which the ordinary student might aspire. In this and his class-work combined, Woodward evinced such special aptitude for biological study that Huxley at once appointed him an assistant. In the following year he was made demonstrator of zoology, and in that capacity he continued to labour zealously and with great ability for the remaining seventeen years of his life, inspiring affection and respect in all with whom he came in contact.

With advancing years, Woodward developed a special aptitude for microchemical work and marine investigation. His fame as a preparateur brought to him numerous friends and coworkers anxious to benefit by his assistance and advice, who are to-day unanimous in their admiration of his manipulative skill and mental attainments. His mind was ever clear, his judgment sound, and by his energetic enthusiasm and foresight he was at times directly influential in uprooting error and misinterpretation in their work, thereby earning their lasting gratitude. His leaning towards marine zoology received a welcome impetus in an opportunity afforded him in the summer of 1887, by Mr. W. H. Hudleston, F.R.S., of conducting a dredging trip in the English Channel, at the conclusion of which his efforts elicited the high encomium of his friend. He later spent his summer vacations in marine research, exploring the fauna of the Channel Islands, working at the Plymouth Marine Station, till finally, through the instrumentality of Mr. E. W. L. Holt, whose friendship he made while he was a student in our College, he was enabled to spend his last three vacations at the Marine Biological Laboratory of the Irish Fishery Board, first at Inishbofin and then at Moyard, where he met his death. Published reports bear testimony to the success of his achievements, and in a recent letter the Vice-President of the "Department of Agriculture and Technical Instruction for Ireland," under which the later work was done, has highly eulogised his labours, character, and attainments. Only a few days before his death, Woodward, in a letter to his friends, wrote with delight of a 380-fathoms haul, which had yielded a *Halo-porphyrus*, a large *Pomatomus*, and about 20 Asthenosomas, rare captures for the British Seas. In describing this catch he presented a word-picture worthy his high artistic ability, which, while testifying to his own great enthusiasm, appealed strongly to that of the zoologists to whom it was communicated.

Woodward from time to time published papers on subjects of special study, the outcome of work done in the scanty leisure his official duties allowed. Among the earlier of these is a valuable paper in the Proc. Zool. Soc. for 1892 on the dentition of Hyrax, Huxleyean in its methods and based on the specimens briefly recorded by Huxley in 1863. In this memoir much that was hitherto confusing in the dentition both of *Hyrax* and other placentalia was rendered clear, and through it Woodward was led to an extended inquiry into the genesis and succession of the teeth in the marsupialia, with the result that his published memoirs placed him in the front rank of comparative odontologists. To have revolutionised our conceptions of the incisors of the Diprotodonts, to have shown that the single so-called successional cheek-tooth of the marsupialia is most probably a retarded pre-molar, and to have contributed to the unravelling of the intricacies of the tooth-complex of the Insectivora, is to have essayed a plucky task and to have earned the lasting gratitude of zoologists of all nationalities.

Woodward, true to his family traditions, cultivated a love of the Mollusca, and upon these animals he published a series of most valuable papers, terminating in a well-nigh exhaustive study of the famous *Pleurotomaria*, published in the *Qu. Jour. Microscp. Sci.* for 1891. His papers upon other molluscs were for the greater part contributed to the Proceedings of the Malacological Society, of which he was one of the original members and the secretary at the time of his death. To read these memoirs is to appreciate the fact that Woodward possessed a knowledge of molluscan morphology second to that of no living malacotomist, and his discussion of the affinities of the Monotocardia set forth in his last published paper may be recommended to those who would gauge his reasoning capacity. Upon the Mollusca he had long specialised, and his concluding act as a teacher was a course of lectures at the Royal College of Science which for depth and originality of treatment will be a lasting memorial to his powers to those who were so fortunate as to hear them. They embodied his preliminary notes and ideas for a book he had intended to write, and it is terrible to think that with his death this brilliant achievement has been cut short.

Ever alert for a new observation, Woodward, as opportunity occurred, made public his passing notes. As an example may be cited his intensely interesting discovery of an earthworm possessed of seven pairs of ovaries. He performed a notable task, involving the spare time of three of his best years, in editing the English edition of vols. ii., iii. and iv. of Korschelt and Heider's "Text-book of Embryology," the emendations, curtailments, and annotations which he effected materially increasing the value of the work.

Woodward was always ready to cooperate with friends and fellow workers in anything which would advance our knowledge of the phenomena of life. He leaves behind him a magnificent series of photomicrographs of the fertilisation process in *Ascaris megalocephala*, made from sections which he had prepared, and an extensive series of preparations, drawings, and notes, upon the spermatogenesis of the Mollusca, the rough arrangement of which constituted the closing act of his College life.

On August 2, Woodward, having just recovered from a surgical operation, journeyed to Moyard, in company with his friend Mr. W. Watson, F.R.S., assistant professor of physics in the Royal College of Science, who had before accompanied him on similar occasions. On Sunday, September 15, after spending the day with their friend Mr. Allies, resident land-owner of Inishbofin and other adjacent islands of the Galway seaboard, on the return journey and within sight of land their boat was capsized by a sudden squall. While Watson and the fisherman in charge managed with extreme difficulty to reach the shore, Woodward, though a good swimmer, sank and entirely disappeared, and although every effort was made to recover the body, it was not brought to the surface till September 27.

He was laid to rest on Sunday, September 29, in the peaceful little Protestant churchyard at Moyard, in the presence of his two sisters, Mr. Watson, Mr. Holt, of the Irish Fisheries Board, and a few of his devoted friends. One reflects with sorrow that circumstances should have combined to remove from the world of action before he was thirty-six a man so universally esteemed. We revere his memory as that of an earnest and original worker, loving and sympathetic, whose self-sacrificing nobility of character, critical capacity, and devotion to the cause of science will long be remembered by the many friends who mourn his loss. G. B. H.

NOTES.

THE Harveian Oration of the Royal College of Physicians will be delivered by Dr. Norman Moore on Friday, October 18.

WE regret to have to record the death, at the age of sixty-nine, of M. R. Koenig, of Paris, well-known for his researches in acoustics, light and heat.

THE *Journal of Botany* records the death, from cholera, in India, on September 14, of a promising young botanist, Mr. William West, at the age of twenty-six. Mr. West had passed a distinguished career at the Royal College of Science, where he obtained the Forbes medal for botany, and at Cambridge, though greatly marred by ill health. He had devoted himself chiefly to the study of freshwater algæ, and had gone to India as biologist to an Indigo Planters' Association.

THE ship *Discovery*, engaged on the British exploring expedition in the Antarctic regions, arrived at Cape Town on October 3. After coaling the *Discovery* will proceed to Simons Bay and thence direct to Lyttelton, not calling at Melbourne in order to save time.

SPEAKING at Upsala to the Swedish Geographical Society on Wednesday of last week, Prof. Nordenskjöld announced that the Swedish South Polar Expedition would be ready to start soon after the 8th inst. After reaching the Falkland Islands, where a depôt will be established, the expedition will continue its voyage southwards. After making their way as far south as possible, the explorers will look for a spot suitable for wintering in. The ship, with three geologists on board, will then return to the Falkland Islands, whence scientific excursions will be conducted throughout the winter. The expedition will probably return to Sweden at the beginning of 1903.

IT is announced in the German semi-official newspapers that the German Government has again placed at the disposal of the Chinese Government the astronomical instruments which were removed from Peking by the German contingent. The Chinese Government has replied that in view of the inconvenience and difficulties which would be involved in conveying the instruments back to China and placing them in their former position it declines the offer.

THE resignation of Dr. Purser, King's Professor of the Institutes of Medicine in the School of Physic, Trinity College, Dublin, is announced. In 1899, on the completion of the twenty-fifth year of his professorship, Dr. Purser's past pupils, in token of their appreciation of him and his services, founded the "John Mallet Purser Medal" for award yearly in the School of Physic to the candidate who obtains the highest marks in physiology and histology at the Half M.B. examination. Prof. Purser's decision has been arrived at, not on account of ill-health or failing energy, but, as the *British Medical Journal* understands, in order that with the increased laboratory accommodation which the Board of Trinity College has provided for the teaching of physiology and histology his successor may have the advantage of equipping the laboratory and organising the work on the more extended basis.

A REUTER telegram, dated October 7, gives further particulars as to the progress of the campaign in Freetown, Sierra Leone, of the Liverpool School of Tropical Medicine against mosquitoes. Up to September 17, 6500 houses had been cleared by Dr. Logan Taylor and his assistants of the receptacles in which the Culex mosquitoes breed, and draining operations against the Anopheles mosquitoes are being pushed forward as much as the rain will allow. In addition to fifty other men employed on the operations of the expedition, two men are specially employed to look constantly after the centre of the town, where the offices, warehouses, and European houses are. The Governor, Sir Charles King Harman, is giving every assistance. Dr. C. W. Daniels, medical superintendent of the London School of Tropical Medicine, who was attached to the expedition and has been studying Dr. Taylor's work at Freetown, has now returned to England. In a report of his observations, addressed to Major Ross, he says:—"In my opinion your efforts have already been crowned with a large degree of success, as there has been a noteworthy diminution in the number of the two first genera of mosquitoes, Anopheles and a kind of Culex, found in the houses. The number o preeding ground has been enormously diminished."

AT the International Congress of Physiologists recently held at Turin a noteworthy tribute of esteem was paid to Sir Michael Foster on his resigning the presidency to his successor, Prof. Angelo Mosso. This consisted in the presentation of a plaque, of which we reproduce (from the *British Medical Journal*) the inscription, granting him the unique distinction of Honorary Perpetual President of the Congress. The wording on the plaque is as follows:—

CONVENTUS PHYSIOLOGORUM INTERNATIONALIS QUINTUS HOC DIE VIRUM ILLUSTRISSIMUM SENIOREM

MICHAELEM FOSTER

PRAESIDEM HONORARIUM PERPETUUM CONVENTUUM PHYSIOLOGICORUM INTERNATIONALIUM CREAVIT

CONVENTUS NOSTRI GRAVISSIMI VIRI DOCTI AUCTORITA TE EIUSDEMQUE STUDIO STRENUO INTEGRE FLORENT FOSTERO CATALOGUM SCIENTIARUM NATURALIUM QUO NEMO IAM NATURAE INDAGATOR CARERE POTEST DEBEMUS GRATIA SIT HONOSQUE PROPUGNATORI NOSTRO! NOMINE CONVENTUUM PHYSIOLOGICORUM INTERNATIONALIUM CONVENTUS QUINTI PRAESES

ANGELUS MOSSO.

AUGUSTAE TAURINORUM AD XV KAL. OCT. A. MCMI.

THE Hanbury gold medal for 1901 was presented on the 1st inst. to Dr. George Watt by the president of the Pharmaceutical Society. This medal, which was established as a memorial to Daniel Hanbury, is awarded biennially for high excellence in the prosecution or promotion of original research in the chemistry and natural history of drugs, and the council of the Pharmaceutical Society are the trustees of the memorial fund.

The sixtieth anniversary of the foundation of the Pharmaceutical Society has just been celebrated by the presentation of a badge of office to be worn by successive presidents of the Society. An illustration of the badge appears in the current issue of the *Pharmaceutical Journal*.

An expedition is about to be despatched to Christmas Island, under the auspices of the London School of Tropical Medicine, for the purpose of investigating beri-beri. The leadership of the expedition has been accepted by Dr. H. E. Durham, who will join the s.s. *Islander* at Port Said on or about October 16. The inquiry will probably extend over a period of twelve months.

Sir Francis Lovell, Surgeon-General of Trinidad, will, according to the *Hospital*, leave England during the present month on a mission to tropical and other countries on behalf of the London School of Tropical Medicine. Lord Brassey will preside at a meeting at the Royal United Service Institution on October 16 to deliver an inaugural address on the opening of the third winter session of the school and to give a send-off to Sir F. Lovell.

The return of Dr. H. F. Knowlton, of the U.S. Geological Survey, from a trip through the John Day Basin, Oregon, is noted in *Science*. The special object of the expedition was to secure collections of fossil plants, and of the vertebrate fauna of the neighbourhood, and much valuable material has, it is reported, been obtained.

Magnetic observatories are being established under the auspices of the U.S. Coast and Geodetic Survey at Sitka, Alaska and in Honolulu.

A course of six popular science lectures for young people, entitled "Peeps into Nature's Secrets," will be delivered at the Kensington Town Hall on October 17, 24, 31, November 14, 28, and December 5. Particulars as to the subjects of the lectures and the names of the lecturers are to be found in our advertisement columns.

Free popular science lectures will be delivered in the museum of the Whitechapel Free Library as follows:—November 12, at 8 p.m., "The Faroe Islands and Iceland," by Prof. C. Lloyd Morgan, and December 11, at the same hour, "The Instincts and Intelligence of Animals," by Lord Avebury. In connection with the course, Dr. T. K. Rose lectured on Tuesday last on "Alloys, and what we know about them."

The *Athenaeum* states that the Berlin Königliche Akademie der Wissenschaften and the Danish Academy at Copenhagen have decided to prepare a collection of all the medical works of antiquity under the title of "Corpus Veterum Medicorum," and will cause a thorough examination to be made of all libraries, Oriental and European, which are likely to contain MSS. dealing with medical subjects.

A meeting of the Royal Microscopical Society will be held on Wednesday, October 16. A paper on the fungi found on germinating farm seeds will be read by Miss A. Lorrain Smith; it will be preceded by an exhibition of mounted specimens of marine zoological objects by Mr. C. L. Curties.

A very successful meeting of the British Mycological Society was held at Exeter from September 23 to 28, when several scarce specimens of fungus were obtained. At the evening gatherings papers were read by the president (Prof. H. Marshall Ward), Miss A. Lorrain Smith, Dr. C. B. Plowright, and Mr. B. T. P. Barker.

The Paris correspondent of the *Times* states that the French Post Office has decided to print upon letters the hours of collection numbered, as in Italian and other railway time-tables, from 1 to 24, or rather to 0, which will signify midnight.

According to the *Lancet*, the New York City Board of Health has adopted resolutions to the effect that the officers of "public institutions, hospitals, homes, asylums, &c., be required to report all cases of malarial fever which come under their observation, giving the name, age, sex, occupation and present address of the patient," and "also information as to whether the attack is a primary infection or a relapse, and the address where the disease was probably contracted"; also "that all physicians in the city of New York be requested to furnish similar information in regard to patients suffering from malarial fever under their care."

Dr. Adolph Gehrmann, director of the Chicago City Laboratory, and Dr. W. A. Evans, of the Columbus Medical Laboratory, have devised a plan of investigation, the main feature of which is to make the experiment with lupus. They hold that just as satisfactory a test can be obtained by inoculating the skin of a human being with the bacillus from an animal as could be got from experiments with pulmonary tuberculosis, with the great advantage that there is no risk to life. Preparations are being made for the experiments, and two persons have already consented to be inoculated.

Scientific visitors to Ceylon, and botanists generally, will be interested to know that a small residential laboratory has been opened at the Hakgala Botanic Gardens, near Nuwara Eliya, at an elevation of 5600 feet above sea-level. The laboratory is a branch of the Peradeniya institution, described in Nature, November 9, 1899, and consists of a small building containing a working room 21 feet × 12½ feet, a living room, two bedrooms, kitchen, &c. The climate is temperate, fires being required in the evenings at least. The botanic garden itself is very beautiful, and occupies an unrivalled position for the study of equatorial hill vegetation, for on one side there are jungles stretching for 25 miles or more into the wet region of the hills, on the other grassy plateaux (patanas, *cf.* Pearson in *Journ.* Linn. Soc., 1899), reaching for an equal distance into the dry region, and extending from 3000 to 7000 feet above sea-level. The garden itself contains both jungle and patana reserves of several hundred acres.

The *Daily News* of October 7 contains a long interview with Mr. Cheesewright on the scheme for constructing a high-speed electric railway between London and Brighton. The system proposed to be adopted is not described, but it is stated that the monorail, of which so much has been heard of late, is not to be used and that each car will carry its own motor. A speed of nearly 90 miles an hour is aimed at, so that the whole journey of 47 miles will only occupy 32 minutes. This high speed is to be made possible partly by having no intermediate stations, and partly by avoiding all curves and gradients by tunnelling wherever hills occur along the route. In addition to the benefit conferred by a half-hourly service of express trains, the public is to be attracted by the cheapness of the fares. The Bill will, without doubt, meet with serious opposition in Parliament from the London, Brighton and South Coast Railway, but we wish the promoters of the scheme every success. We feel sure that the public have only to be taught, by a few striking examples, the immense improvements that electric traction can effect in railway travelling to insist upon its adoption in suitable cases by our existing steam railroads. It is only by healthy competition of the kind that such railways as this will introduce that it will ever be possible to eradicate the often very primitive ideas of comfort and convenience that seem to be possessed by the great railway monopolists; and we hope, and believe, that it will be the function of electric traction to produce as great a change in the comfort of travelling in the present century as did steam railways in that which has just closed.

THE *Electrician* announces that the Hon. A. Lyttelton has been appointed by the Board of Trade as arbitrator to settle the dispute between the Metropolitan and District Railway Companies as to the electrical equipment of the Inner Circle. The disagreement has been long and bitter, and, as the *Electrician* points out, has not only unnecessarily delayed the improvement of the Inner Circle, but has also created an impression that electrical engineers are undecided upon the question of the most satisfactory system of electric traction. That this is true in its broadest sense is no doubt the case, but there are many thoroughly satisfactory systems from which to choose, and it is to be hoped therefore that it will not now be long before one is selected and the alteration of the Inner Circle begins in real earnest.

THE New York *Electrical World and Engineer* for September 28 contains a long article descriptive of the Cooper-Hewitt mercury vapour lamp. A brief description of this lamp was given in NATURE (May 9, p. 39) at the time it was first exhibited in America. The present article is founded on the contents of ten patents just issued to Mr. P. Cooper-Hewitt, and describes in considerable detail the construction and manufacture of the lamps. The chief difficulty met with is apparently in starting the lamp; it is found, however, that a small amount of sulphur introduced into the tube (as sulphide of mercury) makes it much easier to overcome the initial high resistance, but even with this addition a transformer or induction coil is still needed. Once lighted, the lamp is said to burn steadily on 100-volt or 200-volt circuits. The unpleasant colour of the light from mercury vapour can be cured, according to the inventor, by the use of nitrogen in the lamp, this adding the necessary red rays. When originally iutroduced, the consumption of energy was given as only half a watt per candle, a value which is astonishingly small. We await, therefore, with the greatest interest some account of the practical performance of the lamp; unfortunately, it is often a big wait from the patent to the commercial lamp, and it can only be hoped that in this case the time will not be over long.

THE general report on the operations of the Survey of India for the year 1899–1900 shows that the total area triangulated was 41,110 square miles, including 16,000 square miles triangulated in connection with reconnaissance surveys, and valuable scientific observations were effected in the determination of latitudes. The Government of India, in a resolution reviewing the report, notice with interest the large addition to the geographical knowledge of Yunnan and the north-eastern frontier, and acknowledgment is made of the efficient way in which the work of the department has been carried on.

SOME stir has been made in connection with "Kent coal" by the proving in another boring at Dover of certain coal-seams which in reality were discovered some twelve years ago. The original coal-boring was commenced as far back as 1886, and a depth of more than 2000 feet was ultimately reached. The fact that another boring in the immediate neighbourhood has been carried to a depth of 1194 feet is of no particular importance. What is required is that the shaft should be completed down to the workable coal, and the information with regard to this (given in the *Financial Times* of October 4) is that it is hoped to bring up coal "in about fifteen months' time." That the existence of the "coal-field" has been proved "beyond reasonable doubt" will not be questioned; the extent of it remains to be proved. There may be small isolated tracts of faulted Coal Measures, or a continuous field extending ten miles or more.

THE Geological Survey of Egypt has just published an account of Dakhla Oasis by Mr. Hugh J. L. Beadnell. This oasis lies to the south of that of Farafra, an account of which was previously published (NATURE, August 8). It is by far the most important of the four great oases of the Libyan Desert, on account of the number of its inhabitants, the extent of its cultivated lands and palm groves, and the copiousness of its water-supply. The water-supply is derived from an underground bed of sandstone, which is never visible. This is overlain by a bed of red clay and underlain by black clay. The water appears to flow to the surface entirely through artificial wells and bore-holes, ancient and modern. Many of these artesian wells were made during the Roman occupation of the country, some are still in thorough working order, and they are as deep as those bored recently, about 140 metres. The temperature of the waters varies from 78° to 102° F., the heat being due to the depth from which they arise and being modified by local conditions. The water-bearing strata belong to the Nubian Sandstone series (Senonian or Upper Cretaceous). They are overlain by a great thickness of soft Danian beds capped by hard white chalky (Danian) limestone. After the hard capping had been eroded further waste proceeded rapidly, and the formation of great depressions, without drainage outlets, has been due mainly to wind erosion.

THE eruptive rocks of the neighbourhood of Ménerville, Algeria, form the subject of an elaborate essay by MM. Louis Duparc and Francis Pearce, to which Dr. E. Ritter has contributed particulars of the geological structure of the country (*Mem. de la Soc. de Physique et d'Hist. Nat. du Genève*, xxxiii. part 2, 1901). Special attention is given to the liparites and dacites and to their relations with the granitoid rocks (tonalites and micro-tonalites). In the same volume, M. P. de Loriol describes some new echinoderms, including *Pygurus* from Cenomanian and *Echinolampas* from Oligocene strata, and a number of recent species of *Astropecten*, &c., from various parts of the world.

IN the *Proceedings* of the Royal Society of Victoria, vol. xiv. part 1 (August, 1901), geology dominates. Various trachytic rocks are described by Mr. J. Dennant, while the older Tertiary mollusca are in course of description by Mr. G. B. Pritchard, who contributes an account of the lamellibranchs (part 2). There is also a short article by Mr. T. S. Hall on the stages of growth in modern trigonias, which exhibit considerable variation both in the shape of their shells and in their ornament.

IN 1895, a gravitational survey of the kingdom of Württemberg was commenced, and ten stations for the purpose were selected in the first instance on the meridian of Tübingen. The first definite results were obtained in 1899. Dr. K. R. Koch now describes the results of redeterminations made by pendulum methods in 1900, and publishes an account of the methods adopted for eliminating errors of experiment and observation. With the exception of one station, the observations of 1899 and 1900 agree to within about two millionths of the observed values.

A DISTRICT which is free from malaria, in spite of the fact that species of *Anopheles* are abundant and all the conditions are favourable to the occurrence of this fever, forms the subject of a paper by Dr. Grassi in the *Atti dei Lincei*, x. 6. The district is that of Massarosa, about eight kilometres from Viareggio. This district is largely given over to rice cultivation, and, among other noteworthy points, Dr. Grassi finds (1) that malaria formerly existed in Massarosa, but has now practically died out; (2) that its decrease has taken place concurrently with the extension of the rice plantations, notwithstanding that these form a breeding ground for the mosquitoes; (3) that the mosquitoes in question have not acquired any special immunity from malaria, seeing that they have been artificially infected by being allowed to bite a malarial patient; (4) that many of the inhabitants spend a portion of the year in infected districts where they frequently take the disease, showing that they likewise are not immune. The only conclusion which Dr. Grassi can draw is that malaria does not necessarily occur even in districts favourable to its propagation, and hence he thinks it probable that the disease may be easy to stamp out in infected districts, especially with the systematic use of wire mosquito nets. But there is quite a possibility that the district of Massarosa may be visited at some future time by a scourge of malaria.

A REPORT on the work done at the observatory of Catania in connection with the international photographic survey of the heavens is contributed by Prof. A. Riccò to the *Atti dei Lincei*, x. 5. Among the difficulties to be contended against in the work, that of developing the negatives in the hot climate of Catania may be noted. Since the beginning of 1897, the total number of celestial photographs taken was 430, including 250 for the catalogue, 78 of the zone traversed by the planet Eros, 6 of the new star in Perseus, 3 of the occultation of Saturn, and 6 of lunar eclipses. In addition, the writer and Prof. Tacchini took 66 photographs on the occasion of the eclipse of May 20, 1900, in Algiers. A number of measurements, embracing 22,435 stars, have been made on the plates by Signori L. Franco and M. Massa, and reduced by Signor Mazzarella. Among the calculations made by Prof. Boccardi, with the assistance of Signori Traversa and Taffara, we note the construction of tables for the differences of precession depending on the different constants of Struve and Newcomb, catalogues of 2200 stars taking account of proper motion and of the constants of Newcomb, and the reduction to the equinox of 1900 of 8000 stars of the zone studied at Catania. Prof. Riccò hopes shortly to commence the publication of the catalogue.

THE *Century Magazine* for October contains a short article on "How to cross the Atlantic in a Balloon," by Prof. Samuel A. King, with an introduction by Prof. Cleveland Abbe. Prof. King deprecates the attempts to solve a problem of this character by means of flying machines or mechanically propelled balloons, and thinks that the secret of success lies in mastering the problem of maintaining the ordinary spherical balloon at any required height by the aid of the drag rope or similar appliances. The author also points out the necessity of overcoming the propensity of the balloon to rise and fall with varying temperature, and suggests the use of a hood as a protection from solar radiation. With proper precautions, Prof. King considers a Transatlantic balloon voyage now quite within the range of feasibility.

WE have received a copy of the Results of the Magnetical and Meteorological Observations made at the Royal Alfred Observatory, Mauritius, in the year 1899. Some of these results were alluded to in our notice of the Annual Report (NATURE, June 6, p. 135). Magnetic disturbances occurred on nineteen occasions. A list of them is given in an appendix; the principal were: January 28–29, February 12–13, May 3–5, and September 26–27. The mean declination in the year 1899 was 9° 32′·89 west. There were only four tropical cyclones in the South Indian Ocean during the year, viz., on January 1–8, March 3–8, November 30–December 3, and December 10–16. This cyclone passed over Mozambique on the 17th; the length of its path (more than 3000 miles) has seldom been exceeded in the Indian Ocean. The barometrical readings at the Observatory were appreciably affected at a distance of more than 800 miles. Twenty-seven seismic disturbances were recorded at the Observatory during 1899. The small number of recorded earthquakes at Mauritius as compared with other countries is noteworthy.

THE origin and birthplace of the Proboscidea have long been a puzzle to students of evolution and distribution, the mastodons suddenly making their appearance in the middle part of the Miocene, without our having hitherto had the slightest clue as to their connection with more generalised types. The puzzle has, in a great degree, been solved by Dr. C. W. Andrews, of the British Museum, who, during a recent visit to Egypt, was fortunate enough, while travelling in the Fayum district in company with Mr. H. J. L. Beadnell, to come across two Tertiary deposits which have yielded a previously unknown vertebrate fauna, a part of which is described by Mr. Andrews in the September issue of the *Geological Magazine*. From the upper beds, provisionally regarded as Lower Oligocene, were obtained remains of a small mastodon-like animal (Palæomastodon), differing from Mastodon by the simpler last molar and by having five pairs of cheek-teeth simultaneously in use. The other remains are from a lower horizon, perhaps Upper Eocene, but possibly rather older. Most remarkable is a primitive proboscidean (Mœritherium), with a nearly full series of front and cheek-teeth, the latter being of a generalised Ungulate type. That this animal is an ancestor of the mastodons and elephants may be inferred from the enlargement of the second pair of incisors in both jaws and the small upper canines. All the six pairs of cheek-teeth were in use at the same time. More problematical are the affinities of a huge Ungulate described as Bradytherium. From the same beds Mr. Andrews obtained a Zeuglodon, previously described by Dames, and also a Sirenian, probably identical with Owen's Eotherium. A description of the reptiles is promised later. The importance of the discovery can scarcely be overestimated. It is noteworthy, in connection with a recent theory, that the fauna is situated in the Holarctic, and not in the Ethiopian, region.

IN their Report to the forthcoming anniversary meeting, the committee of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne have to deplore the deaths of three prominent members, namely Lord Armstrong, Dr. Embleton and Mr. R. Howse, the last of whom served the Society so well for many years as curator of its valuable museum. We learn that Mr. E. L. Gill, who has been appointed to succeed Mr. Howse, speaks well of the general state of the collections. The finances of the Society, we are glad to hear, continue in a satisfactory condition.

THE *Bulletin* of the Agricultural College at Tokyo contains a capital investigation by Mr. U. Suzuki on the formation and distribution of theine in the tea plant. The seed contains no theine, but this alkaloid appears during germination even in the dark. The roots and stem contain a moderate amount of theine, the bark very little. It occurs in greater quantity in the dormant leaf-buds, and reaches its greatest development in the young leaves, in which 20 per cent. of the nitrogen is sometimes in this form. In old leaves the quantity is greatly diminished. The theine appears to be specially localised in the epidermis of the leaf. Mr. Suzuki has another paper in the same periodical, on the occurrence of organic iron compounds in plants. The seeds of *Polygonum tinctorium* and *Indigofera tinctoria* yield an ash containing 12 per cent. of ferric oxide. The whole of this iron exists in the seed in organic combination, apparently as a ferro-nuclein. The greater part of the iron in plants probably exists in a similar state of combination.

THE decorative symbolism of the Arapaho, a tribe of Plain Indians belonging to the Algonquin stock, is the subject of an essay by Mr. A. L. Kroeber in the *American Anthropologist* (N.S., vol. iii. 1901, p. 308). In all the examples referred to by the author there is, as there is practically everywhere else, a well-developed symbolism and a conventional decoration, which exist not side by side but in each other. Most primitive decoration, no matter how geometric or simple, has significance, and thus is, visually or ideographically, realistic. This fusion of two differing tendencies (symbolism and decoration) is a rule practically without exceptions. It is universal, because it is necessary. At times, as in European civilisation, the two tendencies become more separated, but the more primitive a people is, the more intimately fused in its art will these two tendencies be. Other tendencies also are still combined with these two in a sufficiently early and rude condition of society. The symbolism of the Arapaho is as ideographic as it is realistic, and is as much a primitive method of writing as it is of artistic representation. The author argues that it is incorrect to assume that symbolism, or any other single motive, accounts for the origin of a design. Thus we come to the conclusion that all search for origins in anthropology can lead to nothing but wrong results. The tendencies referred to are at the root of all anthropological phenomena. Therefore it is these general tendencies, more properly than the supposed causes of detached phenomena, that should be the aim of investigation.

THE additions to the Zoological Society's Gardens during the past week include a Black Kite (*Milvus migrans*), European, presented by Mr. J. B. Thornhill; a Diana Monkey (*Cercopithecus diana*) from West Africa, a Yellowish Capuchin (*Cebus flavescens*) from South America, a Fournier's Capromys (*Capromys pilorides*) from Cuba, a Small-clawed Otter (*Lutra leptonyx*), two Bungoma River Turtle (*Emyda granosa*), a Ring-necked Parrakeet (*Palaeornis torquatus*) from India, a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, two Yellow-winged Parrakeets (*Brotogerys virescens*) from Brazil, a South Albemarle Tortoise (*Testudo vicina*) from the Galapagos Islands, eight Wrinkled Terrapins (*Chrysemys scripta rugosa*) from the West Indies, a Grey Monitor (*Varanus griseus*) from North Africa, a Razorbill (*Alca torda*), British, deposited; a Grey Squirrel (*Sciurus cinereus*) from North America, a Mouflon (*Ovis musimon*) from Sardinia, a Common Rhea (*Rhea americana*) from South America, purchased; eight Golden Orfe (*Leuciscus idus*) from European fresh waters, purchased.

OUR ASTRONOMICAL COLUMN.

EPHEMERIS OF ENCKE'S COMET (1901 *b*).—Herr Ch. Thonberg gives a further ephemeris for following this comet, in *Astronomische Nachrichten*, Bd. 156, No. 3740.

Ephemeris for 0h. Berlin Mean Time.

1901.	R.A. h. m. s.	Decl. ° '
Oct. 10	14 19 46	−20 11·2
12	32 42	21 22·9
14	45 20	22 28·0
16	14 57 42	23 26·9
18	15 9 46	24 19·8
20	21 32	25 7·2
22	33 0	25 49·3
24	44 10	26 26·6
26	15 55 2	26 59·4
28	16 5 35	27 27·9
30	16 15 50	−27 52·5

NEW ALGOL-TYPE VARIABLE, 78 (1901), CYGNI.—Mr. A. Stanley Williams has detected variability in the star, whose approximate position is:—

$$\left.\begin{array}{l}\text{R.A.} = 20\text{h. } 18\text{m. } 4{\cdot}0\text{s.}\\ \text{Decl.} = +42^\circ\ 46'{\cdot}4\end{array}\right\}(1855).$$

The measures of brightness were made from photographs obtained with a 4·4-inch portrait lens. Normally the star is about 10th magnitude, falling almost to 12th magnitude at mininum. It appears about a magnitude below normal brightness on a photograph taken 1900 October 21, 13h. 0m. to 13h. 50m. G.M.T.; and minima have also been visually determined on the following dates:—

	h.	m.
1901 Aug. 24	14	27 G.M.T.
Sept. 7	9	43
,, 14	7	29

From these data the elements of the star's variation are:—

Minima = 1901 Sept. 7d. 9h. 43m. + 3d. 10h. 49m. E.

For about 3d. 2h. 19m. the star remains constant at 10·0 magnitude. It then diminishes in 3h. 30m. to 12 magnitude, at which it remains for 50m. Recovery to 10 magnitude occurs in 4h. 10m., the whole change occupying about 8h. 30m. (*Astronomische Nachrichten*, Bd. 156, No. 3740).

PHOTOGRAPH OF THE SPECTRUM OF LIGHTNING.—Prof. Pickering announces that a successful photograph of the spectrum of a lightning flash has been obtained recently at the Harvard College Observatory. The spectrum showed a complicated series of bright lines which have as yet not been individually recognised. No information is at present extant as to the instrument with which this interesting photograph has been taken, but it is to be hoped that the scale is sufficient to ensure accurate determinations of wave-length. For some years back attempts have been made at the Solar Physics Observatory at South Kensington to record the lightning spectrum, using both prisms and gratings in conjunction with short-focus cameras of varying size. Up to the present time, however, no success has been attained, and it is with the greatest interest that the publication of further details from Prof. Pickering will be awaited.

THE ROYAL COLLEGE OF SCIENCE AND THE UNIVERSITY OF LONDON.[1]

I AM sorry to have to sound at the outset a note of sadness. We little thought when the end of the session brought release for us all that before we could meet again death would intervene to prevent one of our number from joining his colleagues and friends at the reassembly. It may not be known to every one present that a deplorable accident has deprived the College of one of the most brilliant and popular of the junior members of the staff. Mr. Martin Woodward, demonstrator of zoology, was the younger son of Dr. Henry Woodward, the eminent keeper of the geological department of the British Museum, who is a personal friend of many of us and respected by everybody. United as father and son were, not only by ties of affection but by constant companionship in their scientific pursuits, we can only guess and I cannot express, the severity of the father's loss. All we can do on this sad occasion is to offer to the family of our departed friend our most heartfelt sympathy. Mr. Woodward entered the College as a student in 1882 and gained the Murchison prize and medal. He was appointed demonstrator by Prof. Huxley in 1885, and has since that time worked under the direction of Prof. Howes. Most of us deplore the loss of a genial, kindly and accomplished friend, but science too is the poorer by this unhappy event, for Woodward was well known as a zoologist, and his extensive knowledge, skill as a manipulator and scientific enthusiasm seemed to promise a high place for him among the biologists of his time.

The next announcement that I am permitted to make is of a more cheerful character. Dr. Stansfield, of the metallurgical division, has been appointed professor of metallurgy in the McGill University, Montreal. All students who have come under Dr. Stansfield's influence will, I believe, gladly unite with his colleagues in wishing him a long, happy and distinguished career in his new home across the sea.

By this time it is probably known to most of the students assembled here that the session now gone has seen the last of two of the most eminent members of the staff as professors in the College. In Sir Norman Lockyer we are losing an investigator of the first rank who may be said to have created a branch of science out of the results of his own researches. But apart from his labours in astronomical physics, I feel that the scientific part of the community owes much to Sir Norman Lockyer for the energy with which he has, on so many occasions, defended the cause of science. Whenever a question has arisen of public opinion or public policy involving the position of science, or of scientific men, he has always sounded the right note. You will, I am sure, join with us his colleagues on the council of the

[1] Address delivered at the opening of the Royal College of Science, October 3, by Prof. W. A. Tilden, F.R.S.

Royal College of Science in offering on this occasion of severing an official link an expression of our earnest wish that he may enjoy many years of health and undiminished strength to carry forward those researches which have made the name of Lockyer famous throughout the civilised world. Prof. Rücker has been called away to occupy the high position of principal of the reconstituted University of London, concerning which I shall say a few words presently. It is difficult to express the profound sense of loss with which I refer to the removal of Prof. Rücker. The members of the College have only the satisfaction of knowing that among their number was found the *only* man who seemed to possess the qualifications requisite for this difficult and arduous position. We also have reason to hope that the association of the College with the University will afford opportunities for the exercise of his friendly cooperation and advice whenever they are required in the work of the College which he has served so long and with so much advantage to all good students.

Days like this are milestones on the road of life for all of us—for you students marking very early stages of the journey—for some of us pretty far advanced toward the end. The metaphor suggests that those of us who have travelled in advance may have something useful to say to those who come after. But I am not going to offer much in the way of advice, because my experience tells me that it will be only very sparingly accepted. After all, the road which you have to follow is not the same, things are altered since *we* passed that way, times are changed, and even if it were not so the spirit of each succeeding generation appears to be unwilling to blend itself with the spirit of the past. The instinct of the young is always to try everything afresh and make up the sum of their own experience, and to regard with suspicion everything which the seniors have to say. But I do not seriously blame them. If it were not thus the world would soon be too wise for happiness, the sense of adventure would no longer brighten the springtime of life which "sicklied o'er with the pale cast of thought would lose the name of action."

Apart from the advice which it is my custom to address to my own class on the conduct of their studies, all I desire to say to the students here can be expressed in a few words. Do not suppose that we seniors are indifferent to your fortunes, to your struggles and successes or failures. On such a day as this we rejoice with those who have reason to rejoice—the winners of prizes and rewards. We would gladly be among you as equals or competitors; we think of our own time and the happiness of something attempted, something done. Go on and prosper. To the newcomers whom we welcome to-day, we wish a like success in the years which are to follow. But it must not be forgotten by them that this demands effort, strenuous and sustained effort. It will not be enough to enter the College every day at a few minutes after ten and leave it at a few minutes before four, and though I do not advise midnight oil, I do venture to say that the chief purpose of the Royal College of Science is not to provide a pleasant kind of club for a few privileged young persons at the expense of the Government or of their own parents and friends.

Aut disce aut discede ought to be written up here as it is in another place.

The third course hinted at on that celebrated notice board is not available here. So you must understand that there are but two alternatives recognised among us—either learn or leave the place.

Independently of the circumstances to which I have already referred as marking in a special way the opening of this present session, there is another subject which must before long assume a position of great importance to us. This College is a recognised school of the new University of London, the majority of the staff are recognised teachers, and those students who choose may become matriculated *internal* students of the University. We cannot yet see clearly to what extent this association will influence our work. We hope for the best; but I think we shall all be agreed that we shall not welcome any changes which will not enable us to live up to the splendid standard of the traditions of our College. Some modifications of detail are, no doubt, from time to time desirable, but we cannot have the standard of attainment and of original work lowered to suit the arrangements of some other institution, however influential.

As it is probable that many of you have not had occasion to consider the subject of the constitution and work of the University, I will venture to submit a few thoughts connected with the subject.

I wonder whether any of you have formed an idea of a university so as to be able to define it. Many people think a university is a place where you may get a degree; a few think it is a place for instruction of a professional or technical kind, still fewer think it is a place for research. An eminent member of the present Government made a speech only a few weeks ago in which at the outset he promised to define a university. In the end, however, he did not supply a definition, but he expressed, certainly very clearly, what in his opinion a university ought to do.

Mr. Chamberlain's view is that a university should do four things—it should teach, it should examine, it should add to knowledge by research, it should show the applications of knowledge. A pretty extensive programme surely!

Cardinal Newman's definition—"A place of *teaching* universal *knowledge*"—does not seem to imply so much, because he almost immediately adds that its object is, *inter alia*, the diffusion and extension of knowledge rather than the advancement. "If, he says, its object were scientific and philosophical discovery, I do not see why a university should have students." ("The Idea of a University," preface).

I will venture a new definition. I should say a university is a place of higher education for those who are qualified by nature to profit by it. And I say that deliberately, holding the opinion as I do that it is not advisable to give more than elementary education to everybody, nor to encourage young people indiscriminately to enter upon a university course. An enormous amount of educational power is now wasted in trying to give a training to intellectual faculties which do not exist, for Providence has not given brains equally to everyone, and many a boy and girl now forced by parents or circumstances to the study of books would be much happier and more useful members of the community if they were taught to lay bricks and to sew and cook and wash, and do these necessary things *well* which are now done badly. This, of course, is not the business of a university, but if the university can so arrange its tests, whether by examination, or in some other way yet to be devised, as to prevent any large number of weaklings from entering upon the university curriculum, it will be doing a kindness to the rejected and a service to the rest of the world.

The new University of London is to be a place of education, we are told, and no longer only a system for testing knowledge got anyhow and anywhere. Its business is to prepare its students for the world. I hold strongly to the view that the *primary* business of a university is not to provide technical instruction from the outset, but to provide those conditions which will help to convert *the boy* into *the man*, and so to prepare him by the cultivation of his faculties that he is then ready to receive instruction in any profession or pursuit which may be marked out for him by his own special gifts or opportunities. All your bachelors, whether in arts or sciences, should be merely well-educated young people with brains. If the programme at school and college has been properly laid out, they cannot have had time to have made much progress in technical work. This does not shut other doors into the professions. A man may become a doctor, a lawyer, an engineer or a chemist without going near the university, but the way through the university must, if things are properly ordered, be always the way chosen by the best students. What I fear is a continuance and increase of the confusion between the processes of education which properly belong to the university and the process of instruction in useful arts or applied science which belongs to the technical school, or, if you please, to the more advanced stages of the university curriculum. Some confusion is inevitable in consequence of the existence from early times in the history of universities of the faculties of theology, law and medicine which are necessarily connected with professions. But in a new university tradition should not be allowed too prominent a place.

In the faculties of engineering and commerce which are to be established it will be disastrous to the cause of higher education if technical practice is to be received as an equivalent for studies which contribute to culture, style and character.

I dissent altogether from the view which seems to be held by some people that the sooner a boy gets to things which will be connected with his future business the better. Doubtless circumstances compel the adoption of this course in some cases, but it is not one which ought to receive the sanction of the university.

The confusion of education with instruction, the mixing of preparatory with professional studies, also leads to much waste of time. All preparatory studies ought to be over by the age of twenty-one, and in some cases even sooner. A young engineer ought not at that age to be learning the physics and chemistry and mechanics, the principles of which he certainly requires for use, but should be free to work at his engineering and what pertains directly to it.

We may hope that the university will provide such a liberal programme that there may be many avenues to the same degree suitable to the needs and circumstances of different classes of students. By this I mean that there should be a very free choice of languages and sciences; and I should exclude altogether from the early stages of a student's career commercial and technical subjects which, however practically important they may be, should only be taken up after the first degree, B.A. or B.Sc., has been reached, and the time for concentration has come.

As to the entrance or matriculation examination, much difference of opinion exists. But whether a classical language be insisted upon or not, and whether one or more modern languages be required, seem to me to be questions far inferior in importance to the requirement that every student admitted to the university should have been trained as far as he has gone in scientific method. This does not mean that he should be acquainted with any particular branch of science, but that by means of scientific study he should have been taught to use his eyes so as to see things clearly, and should have been made to understand the nature and the right use of evidence in coming to any conclusion. This cannot be done by literary study alone, and if not begun early in life will scarcely be accomplished later on.

An educated man must have not only thoughts, but language by which he may express his thoughts intelligibly and with such brevity or fulness as befits the occasion or the nature of the subject. He *must* speak and write his own language correctly. How much more should be required by the university I have no time to consider now, but I think no man of active mind will be content with translations of the literature or even of the scientific treatises of other countries.

The university is a place of education *primarily*, as I have said; but it should also be a place for research, and I will try to say why.

It is not, I think, the first business of a university to make new knowledge for the sake of the knowledge, but it is indispensable to all systems of advanced instruction that students should be associated with teachers who are daily engaged in the endeavour to penetrate by new ways into the regions which lie beyond the boundaries of existing knowledge. In no other way can the teaching of the university be preserved both fresh and free from error. Moreover, it is impossible to arrest the progress of discovery, which will go on elsewhere, however it may be ignored by the university, and how is it to keep abreast of the knowledge of the day except by taking part in the process of making it? Fortunately, the statutes framed by the commissioners distinctly include among the purposes of the University the promotion of research and the advancement of science and learning. This is a matter which cannot be passed by in silence, because it is one of those questions about which difference of opinion exists even within the senate of the University itself. This is shown by what occurred at the presentation for degrees last May. Lord Rosebery was present on the platform and everybody was very glad to see him, but there is great danger in yielding, as the Vice-Chancellor quite naturally did, to the temptation to invite a distinguished visitor to say a few words on the spur of the moment, unless you are quite certain beforehand as to what he will say. For on being asked to speak, Lord Rosebery expressed the opinion that the University should teach and should have nothing to do with research, which proved to my mind that he had never thought seriously about the question. Nevertheless, this remark was received with evident approval by a considerable part of the audience, and was of course reported fully in all the newspapers.

There are two influences exercised by newspapers which seem to me distinctly mischievous. The one is the diffusion of the idea that mere novelty is a virtue, that things of yesterday are more interesting and important than the things of any day before; and the other is that the utterances of a prominent public man, on any subject whatever, are better worth having than the opinion of the man who has given his whole life to it, and I venture to say that public men are not always cautious enough in what they say on subjects to which they have given no attention, considering the weight attached by the public to all their words.

But as to this question of research in all places of higher instruction, what *a priori* judgment can compare with experience already gained? I am not one of those who willingly refer to Germany, for I am weary of the exaggerated nonsense often talked about German competition and English incompetence. But it is easy to see that the universities of Germany have settled the question for us and all the rest of the world by simply acting on the advice and example of Liebig, to whose influence much of her present prosperity is due.

Newman, as already stated, did not think that scientific or philosophical discovery should be the business of a university, but there is a splendid passage in his famous book, "The Idea of a University," which, though he does not refer to research, I cannot refrain from tearing away from its context, because it supplies such a vivid picture of the benefits which attend the existence of such a university in which the art of research is cultivated. He says: "This I conceive to be the advantage of a seat of universal learning, considered as a place of education. An assemblage of learned men, zealous for their own sciences, and rivals of each other are brought, by familiar intercourse and for the sake of intellectual peace, to adjust together the claims and relations of their respective subjects of investigation. They learn to respect, to consult, to aid each other. Thus is created a pure and clear atmosphere of thought, which the student also breathes, though in his own case he only pursues a few sciences out of the multitude. He profits by an intellectual tradition which is independent of particular teachers, which guides him in his choice of subjects and duly interprets for him those which he chooses. He apprehends the great outlines of knowledge, the principles on which it rests, the scale of its parts, its lights and its shades, its great points and its little, as he otherwise cannot apprehend them. Hence it is that his education is called 'liberal.' A habit of mind is formed which lasts through life, of which the attributes are freedom, equitableness, calmness, moderation and wisdom; or what I have ventured to call a philosophical habit. This, then, I would assign as the special fruit of the education furnished at a university, as contrasted with other places of teaching or modes of teaching. This is the main purpose of a university in its treatment of its students."

This I also humbly believe to be the *primary* purpose of university education, and this kept steadily in view all other things, the making of good doctors, chemists, engineers and merchants will be added thereto. This it is which, I think, will also best satisfy the want so eloquently put forward by Lord Rosebery last November, when, speaking not on the spur of the moment, but deliberately in the character of Lord Rector of the ancient University of Glasgow, he declared that "the first need of our country is a want of men. We want men for all sorts of high positions. We want men who will go anywhere at a moment's notice and do anything." And Lord Rosebery rightly thinks that it is the business of universities to produce such men. Of course it will be asked what has all this to do with the Royal College of Science, which is essentially a technical school for the training of teachers and of mining engineers and metallurgists. The answer is that we have accepted provisionally a place in the new university, and so the future working of the university cannot fail to have a deep interest for us. The nature of the entrance examinations which hereafter we shall be obliged to impose, the extent to which our courses of instruction and our college examinations are to be recognised by the university, the position of our associates in the university, are questions which remain to be considered and settled. And, further, I may add that the character and organisation of the teaching side of the university are subjects which will hereafter seriously influence our feelings towards it and the extent to which we shall be inclined to cast in our lot permanently with the new institution. A great opportunity now opens for the establishment of a seat of learning in the richest and most populous city in the world, richest not only in material wealth, but richest in collections of all that is precious to literature, science and art, richest in magnificent traditions and in memorials of the past. The question is, Will the people of London rise to the level of the great occasion? It concerns them more nearly than anyone else. Is London to fall behind a dozen provincial towns which by the exertions or the munificence of their own citizens afford such splendid evidence of local patriotism? London is no longer one city, but has become lately a number of adjacent towns. As they cannot well have separate universities, cannot the new municipalities unite in the same spirit which animates the citizens of Edinburgh and Glasgow, Manchester, Birmingham, Leeds and Liverpool, and help to make a real university common to them all?

I cannot hope to exercise much influence on the progress of events, but "out of the fulness of the heart the mouth speaketh," and I trust the views which I have expressed will not prove to be discordant with those of our late colleague, the distinguished Principal of the University, to whom we all look with hope and confidence for help in the solution of the multitudinous and tangled problems which the University of London still presents.

At the conclusion of his address Prof. Tilden distributed the prizes to the successful students.

MATHEMATICS AND PHYSICS AT THE BRITISH ASSOCIATION.

ALTHOUGH the number of members present at Glasgow was much smaller than was expected, the attendance at the meetings of Section A was well maintained. The papers presented to the Section were unusually numerous, and endeavours had to be made to restrict each speaker to the twenty minutes allowed by the rules of the Section. These endeavours were not always successful, and several papers which came late in the programme had to be given in too condensed a form to be properly appreciated. This was the case, unfortunately, with the "Note on the Theory of the Michelson-Morley Experiment," communicated by Principal Hicks. Prof. Morley, who was present, did not feel justified in discussing the question without having further details from Dr. Hicks. It is to be hoped that the debate which arose after the meeting of the Section was over, will lead to a repetition of these important experiments in the light of the new theory.

As in former years, the discussions which took place in the Section, either impromptu or by arrangement, formed some of the most interesting items of the proceedings. That on the magnetic effects of electrical convection was opened by Dr. Crémieu with a description of his experiments, all of which gave negative results. Dr. H. A. Wilson pointed out several causes which might possibly account for these results, but subsequent speakers expressed doubts as to them being adequate. On the whole, as Lord Kelvin said, we must wait for a repetition of the experiments under the simplest possible conditions before we accept as final a conclusion against which there is so much indirect evidence, and which, if accepted, would necessitate the entire reconstruction of electromagnetic theory.

A paper by Dr. Guillaume introduced a discussion on the proposed new unit of pressure, the megadyne per square centimetre, which was received with favour by the Section. It is very nearly the pressure exerted by a column of mercury 75 cms. long, at 0° C., at sea level in latitude 45°, and differs therefore little from the atmospheric unit at present used. Dr. Guillaume does not propose to interfere with the thermometric scale, and it seemed to be the opinion of the Section that when any change in the scale is made it should be "rationalised," and for convenience have a degree more nearly equal in length to a Fahrenheit than to a Centigrade degree. The discussion opened by Dr. Glazebrook was to have been on glass used for all scientific purposes, but on account of the small time at his disposal he had to restrict his remarks to optical glass, and gave an account of the advances made by Abbé and Schott in the construction of glass having the optical properties necessary for producing achromatic objectives. During the discussion it was pointed out by Mr. Hinks that the durability of some of the new glasses left something to be desired, one of the lenses in use at Cambridge having become partially covered by a fungus the removal of which would necessitate the taking apart of the objective.

Several of the reports of committees contained matter of special interest. That of the Electrical Standards Committee included the results obtained by Mr. S. Skinner on the slight difference of the amounts of silver deposited by the same current from solutions of silver nitrate in water and in pyridine. The Seismological Committee finds that the wind accounts for certain frequent small movements of the seismograph trace whose source had hitherto escaped detection. The report of the Committee on Underground Temperature contained tables of observations of temperature made in Michigan and in Silesia, down to depths of about 2000 metres. It seems, however, of little value to publish such tables without information as to the nature of the strata met with at different depths. The report of the Committee on the Determination of Magnetic Force on board Ship consisted of Captain Creak's description of the modified dip circle he has devised for carrying out the determination by Lloyds' method. The tests of the instruments having proved them satisfactory, two have been sent out in the *Discovery*, and one in the German ship *Gauss*, for use in the Antarctic.

Of the ordinary communications, that by Lord Kelvin on the absolute amount of gravitational matter in any large volume of interstellar space probably attracted the largest audience. Lord Kelvin gave a *résumé* of the arguments he brought forward in the *Philosophical Magazine* for August, to show that if 25 million years ago 1000 million masses equal to that of our sun had been distributed through a sphere of radius 3×10^{16} kilometres they would have now acquired velocities about equal to those known to be possessed by the stars visible to us. It seems, therefore, probable that the total amount of gravitation matter of our universe does not differ greatly from that of 1000 million suns. The same line of argument may be carried out for the mass distributed as atoms initially throughout space, and we then have the nebular hypothesis reduced to atomic dynamics.

Prof. Gray gave an account of the work he is doing in conjunction with his pupils on the viscosities of liquids and solids and the effect on them of changes of temperature, magnetisation, &c. Some of the most interesting of the results obtained were communicated to the Royal Society in June, and the experiments seem likely to have an important bearing on molecular theory. Dr. J. T. Bottomley's paper on radiation of heat and light from a heated solid was taken at the end of a sitting and received scant attention considering the importance of the subject. Dr. Bottomley finds by measuring the power absorbed by electrically heated polished or blackened platinum wire and strips placed in vacuo, that at the same temperature the blackened radiates four or five times as much energy as the polished surface, and that when the luminous appearance of the two is the same their temperature is practically the same. Prof. Morley and Mr. Brush have been determining the influence of water vapour on the energy lost by a heated body placed in an enclosure containing air, hydrogen or water vapour. At low pressures water vapour transmits heat more rapidly than air, but not so rapidly as hydrogen. In this connection Prof. Morley has devised a new pressure gauge capable of measuring pressures down to about a ten-thousandth of a millimetre of mercury. It consists of a U-tube containing mercury, on one of the free surfaces of which the pressure to be measured acts. The depression produced is measured by the amount of tilt of the tube necessary to bring the two mercury surfaces back into contact with two platinum points in the tube. A complete account of the arrangement is to appear shortly in the *American Journal of Science*.

Prof. Callendar communicated the results of applying a small correction hitherto thought negligible to the values of the specific heat of water between 0° and 100° C., determined from the observations of Dr. Barnes with Callendar's apparatus. The high degree of accuracy which Mr. E. H. Griffiths has attained in measuring temperature by the platinum thermometer has enabled him to determine the depression of the freezing points of extremely dilute solutions, and as a result he can now state that the depression produced by dissolving one gram-molecule of potassium chloride in a thousand grams of water is, to about one part in two thousand, double that produced by the solution of one gram-molecule of sugar.

Mr. B. Hopkinson brought forward a new argument for the existence of an ether. Although at certain times the two stars of a spectroscopic binary are moving in opposite directions at right angles to the line of sight with great velocities, the doubling to be expected, if aberration is due to relative motion of source and receiver, has never been observed. Aberration must then be due to the motion of the receiver with respect to something not matter, and be unaffected by relative motion of this something and the source. This "something" is the ether. Dr. Johnstone Stoney was unable to attend the meeting, and his paper on the possibility of obtaining interference between light from different sources had to be taken as read. Dr. Stoney believes he has obtained undoubted experimental proof of the possibility, but the matter must be held over till his proof can be considered and discussed.

Prof. Schuster gave an account of his experiments on the passage of electricity through mercury vapour. They seem to indicate that pure mercury vapour is a non-conductor.

Prof. Minchin described the latest form of his photo-electric cell, which consists of two selenium coated aluminium wires dipping into certain solutions, and produces a measurable E.M.F. when one wire is exposed to the light of a star. An arrangement so sensitive should have a great future before it.

In the meteorological department of the Section, papers by Messrs. W. N. Shaw and R. W. Cohen, on the effects of sea temperature and wind direction on the seasonal variation of air temperature in these islands, were read. The presence of the sea delays each seasonal change of temperature, and the authors are investigating the effect of the direction and temperature of the prevailing winds on the air temperature at the four principal stations of the Meteorological Office. Mr. F. N. Denison has found that the depression of the earth's crust due to an area of high barometric pressure can be detected by a seismograph at great distances from the centre of the depression, the instrument being tilted towards the area of high and from that of low pressure. The approach of a barometric depression is therefore indicated by the seismograph long before the barometer shows any sign of it.

In the mathematical department, Prof. Mittag-Leffler communicated a paper on a criterion for recognising the irregular points of analytic functions, an important extension of the theory of convergent series of powers to convergent series of functions. Mr. R. W. H. T. Hudson extended the idea of Newton's diagrams to the theory of differential equations. Prof. G. H. Darwin communicated a paper on Poincaré's pear-shaped figure of equilibrium of a rotating liquid, and Col. Cunningham announced the discovery of certain high primes, mainly by the use of the numbers called by Euler "idoneal." Several new theorems dealing with idoneal numbers were announced by Col. Cunningham and the Rev. J. Cullen. Further papers dealt with modified proofs of propositions already known.

In the astronomical department, Prof. Turner in his opening address called attention to the need of cooperation in astronomical work, cooperation which should not sink the individuality of the observer, or substitute routine for an alert spirit of inquiry and investigation. Prof. G. Forbes brought forward several facts which seemed to support his contention that there is a planet beyond Neptune with a mass about equal to that of Jupiter. Father Cortie announced that he had found the faculæ on the sun's surface followed the same law of rotation as the spots, and Mr. Hinks showed that the objections which had been raised to the determinations of the solar parallax from photographs of Eros, on the ground that it was a moving object, were unfounded. At the close of the sitting, Prof. Turner announced that Prof. Pickering had succeeded in taking a photograph of the spectrum of a lightning flash, and that important information would be forthcoming when the photograph had been measured.

C. H. LEES.

ZOOLOGY AT THE BRITISH ASSOCIATION.

THURSDAY, September 12.—The president's address was taken later than usual in order to afford opportunity of attending some other sectional address. In the afternoon the reports of committees and a few papers were taken, as follows:—

(1) Dr. Hepburn and Dr. D. Waterston gave a paper on the pelvic cavity of the porpoise as a guide to the determination of the sacral region in Cetacea. The chevron bones distinguish the caudal vertebræ in cetaceans, but there is no easy method of distinguishing sacral from lumbar vertebræ. The authors find a true pelvic cavity in the porpoise which corresponds to five pre-caudal vertebræ, and they suggest that these five vertebræ are to be regarded as sacral in Cetacea. They find considerable variation in the position of this sacral region in the different Cetacea, which they consider to be due to differences in the numbers of dorsal and lumbar vertebræ present.

(2) Prof. R. J. Anderson, on the relationships of the premaxilla in the bears. The premaxilla differs in the level and breadth of its articulation with the frontal, just as the nasals reach higher up and further back in some bears than in others. Genera allied to the bears approach them in regard to the relation of the premaxilla to the frontal, so do *some* of the Canidæ, but to a less degree, whilst other forms of the latter family have a wide interval between the premaxillæ and frontals. It is not difficult to account for the enlarged premaxillæ of elephants, whales and rodents, or for the short stout forms in Suidæ, &c.; but the seals, while in some respects resembling the arctoids, differ much in their premaxillæ. The isolated centres met with in some animals in the frontal region (*e.g.*, *Gorilla*, *Ursus*, *Labistus*) are wormian. The separate bone found in connection with the ventral part of the premaxilla in monotremes is not found in other mammals.

(3) Reports of Committees:—"On bird migration in Great Britain and Ireland."—The committee expresses its most grateful admiration of Mr. Eagle Clarke's invaluable services. Mr. Eagle Clarke supplies detailed statements on the migrations of the skylark and of the swallow, those of the former being of an extremely complicated nature.

"Index Animalium."—During the last year the period 1758–1800 has been dealt with. Arrangements had been made with the Cambridge University Press to begin the work of printing this first part of the Index in May, 1901. The indexing of 1801–1900 now continues. The whole of the work, as usual, has been done by Mr. C. Davies Sherborn.

Zoology of the Sandwich Islands.—This eleventh report states that Mr. R. C. L. Perkins has been working during the last year almost solely on the island of Oahu. The present position of the work is discussed.

Coral Reefs of the Indian Regions.—Mr. J. Stanley Gardiner has sorted out the marine collections from the Maldive and Laccadive archipelagoes into groups for the specialists, and some of these groups have already been worked up. The collections seem very complete, and the committee asks for assistance in publishing.

Table at the Naples Zoological Station.—In addition to the usual statistical information the committee give reports from Dr. Reginald Buller on the fertilisation process in Echinoidea, and from Dr. Hamlyn-Harris on the statocysts of Cephalopoda.

Table at the Plymouth Marine Laboratory.—The occupation of the table during the year is reported on.

Natural History and Ethnography of the Malay Peninsula.—Mr. W. W. Skeat gives an account (to Sections D, H and K) of the Cambridge Exploring Expedition. An extensive collection of vertebrates was made, and the first two species of *Peripatus* found in the Malay peninsula were discovered. These latter have recently been described by Mr. R. Evans.

Plankton Investigation.—Mr. Garstang reports upon his periodic work in the English Channel.

On September 13 the following papers were taken:—

(1) Mr. J. Stanley Gardiner, on the coral islands of the Maldives.—The Maldive group to the south-west of Ceylon is made up of a large series of comparatively shallow banks, separated from one another by channels of about 170 fathoms in depth. They extend north and south as a chain, double in the centre, for 550 miles. All are covered with coral reefs, arising to the surface. Some banks have on their circumferences the single ring-shaped reefs of perfect atolls, while others are studded with numbers of small isolated reefs, many of which are of circular form with shallow lagoons (atollons). The two classes of bank merge into one another, and the changes, going on at the present day, are such that the atolls may be supposed to have arisen by the fusion of the smaller reefs. All land in the group owes its origin directly or indirectly to elevation, and in most atolls is very markedly washing away. Everything points to a state of rest at the present day. The atoll reefs are perfecting themselves on all sides, and passages are closing up. The reefs, however, are not broadening, but to a certain point narrow as they become more perfect. The central basins of atollons are everywhere coming into free communication with the lagoons of the atolls. There is no trace of the filling in of the latter; indeed, such evidence as was found pointed, on the contrary, to their further widening and deepening and to the gradual destruction of the shoals and lands within the encircling reefs. The Maldive group marks the existence of an ancient land-area, but the changes going on are not consistent with the view that the reefs were formed on the subsidence of the land. The various reefs appear rather to have grown up separately on slight elevations of a common plateau at a depth of 150 fathoms,

while the plateau itself seems to have been formed by the washing away of the original land by wave and current actions.

(2) Mr. E. J. Bles, on a method for recording local faunas. Mr. Bles urges the use of uniform slips as in a library card catalogue, each slip to contain name of species, locality, date of capture, &c. The advantages of cooperation should be combined with this coordination of the recorders.

(3) Prof. J. Arthur Thomson's germinal selection in relation to inheritance was an attempt to test the utility of Weismann's subtle theory as a provisional interpretation of some of the important facts of inheritance. After inserting "a struggle of gametes and potential gametes" between the "histonal" or intra-organismal selection of Roux and the "germinal selection" of Weismann, he sought to extend Weismann's conception, pointing out that within the germ there might be three forms of struggle: (*a*) between determinants of the same character; (*b*) between determinants of quite different kinds; and (*c*) between the determinants and their somatic or more external environment. But the bulk of the paper was devoted to testing the theory as a unifying interpretation of otherwise unrelated facts of inheritance.

(4) Prof. Thomson also gave some notes on the behaviour of young gulls artificially and naturally hatched. After describing the actions of the young *Larus ridibundus* in the first three days after hatching, he noted that the young birds never ate deleterious or useless substances; that it took them a relatively long time to learn to recognise water in a shallow dish, though they drank with avidity when plunged into water or when they got their bills wet by pecking at their feet or at particles while standing in the water; that swimming and preening movements were seen in great perfection as early as the third day; and that the "kin-instinct" seemed very strong.

In the afternoon there were two papers by Mr. W. S. Bruce, on the fishes of the Coats' Arctic Expedition and preliminary notice of the fauna of Franz Josef Land, a paper by Dr. T. H. Bryce on heterotypical division in the maturation of the sexual cells, and a demonstration by Prof. Marcus Hartog and Mr. Nevil Maskelyne on the mechanism of the frog's tongue, showing the method of protrusion by means of a model.

On Saturday, September 14, the Section did not meet, but a number of the biologists took part in a very pleasant and successful expedition in connection with the Millport Marine Station. The party, on board the steamer *Ivanhoe*, accompanied the steam-yacht *Mermaid*, belonging to the station, on a dredging and trawling excursion round the shores of Cumbræ. In the afternoon the party landed and inspected the Marine Station, including aquaria, laboratory and the "Robertson" Museum. Copies of a special handbook issued by the Marine Biological Association of the West of Scotland, and compiled by the hon. sec., Mr. J. A. Todd, were supplied to the visitors. This gives an interesting account of the history of the Marine Station, and of the successive benefactions—Sir John Murray's "Ark," the "David Robertson" Museum, the present building, due largely to the liberality of Dr. Thomas Reid, the steam-yacht *Mermaid*, and other gifts from an anonymous donor—crowned, we believe, by an additional 3500*l*. given since this excursion to provide an extension of the building.

On September 16 the following papers were laid before the Section:—(1) Mr. J. J. Lister, on dimorphism in Foraminifera, with lantern illustrations. This subject was exemplified by the life-history of *Polystomella crispa*, in which two forms occur, the microspheric and the megalospheric, differing from one another in the size of the central chambers, the character of the nuclei and in relative frequency. The transition from the microspheric to the megalospheric form was traced by a series of photographs of an individual of the microspheric form, the protoplasm of which emerged from the shell and broke up into a brood of megalospheric young. These having reached maturity give rise in turn to actively motile zoospores. It was shown that the facts of the life-history are inconsistent with the view that the two forms represent the two sexes, but confirm that which regards them as alternating or recurring forms in a cycle of generations. While the megalospheric form arises asexually, there are considerable grounds for supposing that the microspheric form is produced by the conjugation of zoospores.

(2) Dr. J. Y. Simpson, on the relation of binary fission and conjugation to variation. The species specially examined were *Paramecium caudatum* and *Stylonichia pustulata*, and examination was restricted to (*a*) general outline, (*b*) total length, (*c*) extreme width, (*d*) distance between contractile vacuoles, (*e*) length of middle caudal bristle. In all five points variation was found. This was illustrated by microphotography. The author contends that there is variation in binary fission, and that the process is not merely one of duplication.

(3) Mr. W. E. Hoyle, on a new form of luminous organ, intrapallial, in Cephalopoda.

(4) Mr. R. Shelford, on the habits and life-histories of some Sarawak insects, illustrated by the lantern.

(5) Prof. J. C. Ewart gave a lantern demonstration on zebras and zebra hybrids. This was illustrated by an exhibition of three of the actual hybrids in the medical quadrangle (see description below).

(6) Dr. J. F. Gemmill, on a large nematode parasitic in the sea-urchin. This worm, which the author proposes to call *Echinonema grayi*, occurs in the perivisceral cavity, and seems to have escaped notice except for a brief mention by A. E. Shipley in 1900. The females are 60 to 150 cms. in length, and the males only 5 to 10 cms. An account of the anatomy was given.

(7) Mr. F. H. Marshall gave exhibitions of abnormal specimens of *Nephrops*, and of microscopic preparations of mammalian hairs.

Some of the members of the Section took part on the Monday forenoon in a conference between Sections C, D and E on the subject of limnology, with special relation to the scientific study of the lakes of the British Islands. It was announced that Sir John Murray and Mr. Lawrence Pullar had undertaken to defray the expenses of a survey to be undertaken by three scientific men during five years, and the conference discussed the best methods of carrying out the proposed scheme from the points of view of the different sciences involved.

On September 17, four papers were taken in the morning:—

(1) Mr. C. Forster Cooper, on the fauna of an atoll, with lantern illustrations.

(2) Mr. L. A. Borradaile, on the land crustaceans of a coral island. The author pointed out the importance of land crustaceans in the economy of tropical nature in general, and of a coral island in particular. He then enumerated the species he had observed in the island of Minikoi in the Indian Ocean with an account of their appearance and habits. Special emphasis was laid on the interesting land hermit-crabs of the genus *Coenobita*.

(3) Mr. J. S. Budgett, on the youngest known larva of *Polypterus*, with lantern illustrations. From his observations on the structure of the pectoral fin, the primordial cranium and the visceral arches of this larva, obtained in the Gambia in 1900, the author believed that the Crossopterygii showed affinities with the Selachii, but that the structure and development of the urinogenital organs, though in both probably of a very primitive nature, disclosed teleostean affinities, while the structure of the osseous skeleton has in many points been shown to resemble that of the Stegocephali and Amphibians. He therefore concluded that the Crossopterygii were a central group retaining relations with most of the great groups of Ichthyopsida, but not being actually ancestral to any one of them.

(4) Mr. J. Graham Kerr, on the origin of the vertebrate limbs. The author gave a short account of his hypothesis of the homodynamy of the vertebrate paired limbs with the true external gills. After pointing out the absence of solid foundation in fact for the two most widely accepted hypotheses of the origin of the paired fins, and having criticised these two views generally, he accentuated the probability that the two main types of limb, Ichthyopterygium (including Archipterygium) and Cheiropterygium, were derived independently from a simple styliform projection of the body (Stylopterygium), which was used, not for swimming, but for clambering about a solid substratum. This, from the evidence of Braus and others, was probably somewhere about the hind end of the branchial region. Now were there any projections from the body in this region from which the motor stylopterygium could have become evolved? Mr. Kerr pointed out that in the true external gills there existed a series of organs, projecting in various groups of lower vertebrates from the visceral arches (I.–VI. inclusive). These organs were potentially motor organs, as was shown by their powerful muscular apparatus and by the active flicking movements which they could perform; they were also potentially supporting structures, as was shown by the so-called "balancers," in which form the mandibular pair persisted in many Urodeles. He held that by far the simplest view of the origin of the paired limbs was that

they had developed out of a couple of the more posterior pairs of external gills, the girdles to which they were attached representing the skeleton of the corresponding branchial arches.

Mr. Kerr in the course of his paper controverted the view that the external gills were secondarily developed adaptive structures in the groups in which they occur; he also dealt with the difficulty that most true external gills contain no cartilaginous axis, pointing to the barbels of *Xenopus* with their cartilaginous axis, and to the rod of cartilage found by Budgett projecting into the base of the external gill of the hyoid arch of the young crossopterygian.

Tuesday afternoon's meeting of the Section opened with a lantern lecture by Major R. Ross on the story of malaria. He dealt in detail with the history of the various stages in the discovery and establishment of the mosquito theory, from the first fact, the discovery of the malarial pigment in 1849, to Manson's crucial experiment in 1900. He then passed to the prevention of malaria and other mosquito-borne diseases, and gave an account of the experiments now in progress in Sierra Leone and Lagos.

The session ended with three exhibitions—Dr. Francisco P. Moreno showing photographs of fossils in the La Plata Museum, Prof. Gilson a new sounding and ground-collecting apparatus, and Dr. J. Rankin a new orientating apparatus for the Cambridge microtome.

During the last few days of the meeting three of the zebra hybrids bred by Prof. Ewart were on view in the quadrangle (medical) adjoining the sectional meeting room. These hybrids were: (1) "Remus," the largest of the three, was born May, 1897, dam a 14-hands bay half-bred Irish pony. The mane of "Remus" was all but removed last April. (2) "Sir John," the small stout one, was born June, 1899. His dam is a yellow and white Iceland pony. "Sir John" probably reproduces fairly accurately the coloration of the primeval common ancestor of the horses and zebras. (3) "Birgus," the slender hybrid, was foaled May, 1900. His dam is a chestnut 14-hands polo pony. In 1898 this polo pony had twin hybrids, one of which goes extremely well and quietly in harness.

It is impossible to conclude even a brief account of the zoology of the meeting without at least a passing reference to the excellent volume on the natural history of Glasgow and the west of Scotland issued under the title "Fauna, Flora and Geology of the Clyde Area" as one of the three handbooks prepared by the local committee. A large number of specialists have collaborated in the production of the lists and articles, the result being a work of great completeness and of more than local interest, and of permanent value.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE work of Section E at the meeting at Glasgow maintained the feature which has been noticeable for the last two or three years; the number of "popular" papers was comparatively small, while papers presenting the results of detailed research, or laying down foundations of future work, formed a distinct majority. Although the change has led to a marked diminution in the average numbers attending the meetings of the Section, it must be regarded as satisfactory, inasmuch as it indicates an increase in the annual output of scientific work by geographers in this country, and the fact is all the more gratifying in view of the difficulties in the way of geographical research, to which Dr. Mill drew attention in his presidential address. Dr. Mill laid his finger upon the true reason why "the few attempts which have been made in this country to promote the study of geography or to diminish the discouragements to geographical research have had but slight success" when he pointed out that "amongst the not inconsiderable number of teachers of geography in the universities and colleges of Great Britain there is not one man who receives a salary on which he can live in decent comfort so as to devote all his time, or a substantial part of it, to geographical research; and the same is true of every official of all the geographical societies." Until there are properly equipped centres offering adequate opportunities for research as well as teaching, we cannot expect students of geography to receive the intellectual stimulus which research alone can give, nor can we develop a system of geographical teaching suited to our special educational needs and methods, and capable of satisfactory extension to our schools.

Following the delivery of the president's address on Thursday morning, Mr. E. G. Ravenstein read a paper on Martin Behaim. Martin Behaim fills a place of some prominence in the history of geography on three grounds: firstly, the historian João de Barros, writing in 1539, states that he was a pupil of Regiomontanus, and was appointed a member of a committee which devised a method of "navigating by the sun"; secondly, Behaim claims to have commanded a vessel in Cão's second expedition; and thirdly, during a visit to Nürnberg in 1490–93, he superintended the manufacture of a terrestrial globe, which survives to this day. Mr. Ravenstein seriously doubts the first claim, rejects the second, and fully admits the third.

The tenth and final report of the Committee on the climate of Tropical Africa was also presented. In this report, drawn up by Mr. Ravenstein, abstracts of the meteorological observations received during the year are published, and a review is given of the work of the Committee since its first appointment in 1891. In completing its labours, the Committee recommends that where local provision is not made for the publication of observations, the registers should be forwarded in future (through the Foreign or Colonial Office) to the Meteorological Council or to the secretary of the Royal Meteorological Society. Copies of the "Hints to Observers," published by the Committee, may be obtained from the secretary of the Royal Meteorological Society.

Dr. A. J. Herbertson read a paper on the morphological divisions of Europe, in which he pointed out the inadequacy of the ordinary physical map for many of the purposes of the geographer. The paper was illustrated by a new "morphological" map of Europe, based primarily on the work of Suess, in which Europe was divided into physical regions, taking into account, not merely configuration, but composition and structure, and by a few well-chosen examples, such as the comparative structure of the south-east of England, the Seine basin, and the German Jura, Dr. Herbertson showed the undoubted value of maps of this type for purposes of both research and teaching.

The first paper in the afternoon was one by Mr. G. G. Chisholm, on geographical conditions affecting British trade. After illustrating his contention that geographical conditions, although often disregarded, were really important factors to be taken into account, by pointing out that Glasgow remained unimportant, both commercially and industrially, until the development of Transatlantic trade, Mr. Chisholm discussed the effects which improvements in means of communication, electric transmission of power, and other modern developments, are likely to produce in the trade of Great Britain as compared with that of other countries.

Prof. Alleyne Ireland read a paper on the influence of geographical environment on political evolution, in which he discussed the possibilities of native government within the tropics, concluding that while the natives of the tropics are not deficient in intellectual power, their "climatic discipline" renders them unfitted to play the part of legislators or responsible administrators, or to maintain a government sufficiently stable to admit of proper commercial development.

The Rev. Thomas Lewis gave an account of journeys in Portuguese Congo, in the course of which he has collected much valuable topographical information.

Friday morning was devoted to the geography of Scotland, and the proceedings afforded gratifying evidence that in spite of difficulties Scottish geographers are prosecuting research along various lines with vigour and success.

The first paper was one by Prof. G. F. Scott Elliot, on the effects of vegetation in the Valley and Plain of the Clyde. The general characters of the Clyde Valley in seven separate divisions were described—the sub-alpine, heather and peat, sheep pasture and arable districts; the Falls of Clyde canyon, the valley below the falls, and the flat and alluvial plains—and the successive stages in the formation of the valley slope were traced in a number of instances. It was shown that a perfect series of transitions can be found from the vertical scaur cut by the river to the continuous steep slope characteristic of the neighbourhood, and that the formation of the slope, in its various stages, was controlled by the vegetation.

Miss Marion Newbigin gave an account of a scheme which has been undertaken by the Scottish Natural History Society at the suggestion of Sir John Murray. It is proposed, firstly, to arrange, in a readily available form, references to papers already published on the natural history of the Forth Valley, including its botany, zoology and geology; and, secondly, the Society proposes to utilise its various sections and the labours of its individual members in the acquisition of a mass of detail in regard to the existing organic conditions in the valley of the Forth.

Prof. W. G. Smith described the methods and objects of the botanical survey of Scotland inaugurated by his brother, the late Mr. Robert Smith. The difficulties of grouping the flora comprehensively into "plant associations" having been got over, and the proper cartographic methods elaborated by a number of experimental surveys, it remains to carry out the work on the large scale. Great interest was taken in Prof. Smith's paper, and in the course of the discussion which followed Major Craigie gave the satisfactory assurance that when the survey is put on a definite basis it will receive assistance from the Board of Agriculture in the way of supplying details.

In the afternoon Dr. Francisco Moreno read an important communication on the anthropogeography of Argentina, in which he summed up the existing evidence as to the origin and distribution of different races of mankind in South America, and stated a number of problems awaiting further investigation. Mr. Hesketh Prichard gave an account of his journey in Patagonia, undertaken recently for the *Daily Express*. At the close of the meeting, Mr. Reclus-Guyou exhibited a specimen of the maps on natural curvature prepared by M. Elisee Reclus. These maps are drawn on a sheet of aluminium stamped to the curvature of a globe whose radius has the proportion to that of the Earth of the natural scale of the map.

On Monday morning Captain Lemaire gave an account of the Belgian expedition to Ka-Tanga under his command. The first part of Captain Lemaire's paper described the scientific results of the expedition, amongst the most important being an exhaustive investigation of barometric methods of determining altitudes in low latitudes; the second part consisted of an exhibition of part of the excellent collection of photographs made by the expedition. The expedition mapped more than 6600 kilometres of itinerary on a large scale, and one of the most remarkable features of the expedition was that "they left behind them no cause for complaint, or any ground for ill-will, among the native populations." Captain Lemaire's work was very appropriately described as a model and a guide for all modern explorers in Central Africa. In connection with this paper an exhibition of water-colour sketches by M. Dardennes, artist to the expedition, was held in the gallery of the Glasgow School of Art.

Dr. Vaughan Cornish presented the first report of the Committee on terrestrial surface waves, which dealt chiefly with observations of snow waves and ripples, and snow drifts and snow caps, made by Dr. Cornish during last winter in Canada. Considerable difficulties were met with in obtaining satisfactory photographs of the details of snow surfaces, but Dr. Cornish's admirable slides showed that these have been successfully surmounted.

Mr. H. N. Dickson read a paper on the mean temperature of the atmosphere and the causes of glacial periods, in which he drew attention to the fact that any change which may have occurred in the mean temperature of the atmosphere was probably accompanied by change in the temperature gradient between equatorial and polar regions, and therefore by modifications of the atmospheric circulation. It was suggested that this had not been sufficiently taken into account in discussing glacial and other phenomena connected with secular changes of climate, and that by taking it into consideration a comparatively small gain or loss of heat would suffice to produce the changes of temperature deduced from the geological record, while the changes in circulation at the earth's surface would account for many peculiar features of distribution.

On Monday morning a joint meeting was held with Sections C (geology) and D (zoology), to discuss the objects and methods of the scientific study of the lakes of the British Islands with special reference to the scheme of survey about to be carried out by Sir John Murray and Mr. Lawrence Pullar. Dr. Mill, who presided, read the following letter from Sir John Murray explaining the scope of the proposed survey, and stated that it had been undertaken as a memorial to the late Mr. F. P. Pullar:—

"I am sorry it is not possible for me to be present at the meeting of the British Association this year. I am very pleased to learn that a discussion has been arranged with reference to the proposed bathymetrical, physical, and biological survey of the fresh-water lakes of the United Kingdom. I have not, as yet, definitely settled anything with regard to the undertaking, but my idea is to endeavour to obtain the cooperation of three young university men who would take a real interest in the investigation and be likely to make something out of the researches in the way of experience and reputation; one to be a physicist, one a zoologist, and one a botanist. I propose to offer for the first year a salary of 100*l.* and expenses while actually engaged in field work at a rate a little better than is given to members of the Geological Survey. The principal work will be to sound the lakes and prepare the bathymetrical charts. While this is going on observations will be made concerning the temperature of the water at different depths and different seasons of the year, as well as how the distribution of temperature in the lakes is affected by wind and other conditions. Observations will also be made on the distribution of plants and animals in the different lakes at various depths and seasons, and on the deposits at the bottom of the lakes. The geological structure of the district in which the lakes are situated, the rainfall, and other allied phenomena will likewise receive attention. I would expect those who take part in the work at a salary to give their whole time to these investigations, and to work under my direction, but they will receive full credit for their work, and will be allowed to publish results in their own names. It may be possible to receive assistance from others who cannot give their whole time to the researches, and also to make collections and observations for those who are engaged in the study of special branches of limnology. It is probable that I will arrange to publish separately the results obtained in each catchment as soon as the survey of each basin has been completed, and then to publish a general account of the fresh-water lakes of the United Kingdom when the practical work of the survey has been finished. I propose to commence the organisation of the undertaking soon after my return to Scotland, and I hope to complete the whole work in five or six years."

A full debate followed, in which both geologists and biologists took part. Mr. John Horne intimated that the Geological Survey would, given the formal approval of the Board of Education, place any information in their possession at the disposal of Sir John Murray and his colleagues, and Colonel D. A. Johnston, of the Ordnance Survey, expressed his warm interest in the undertaking. A formal resolution expressing the great gratification of the meeting at the decision to carry on the work under the direction of Sir John Murray, and its sense of the munificence of Mr. Lawrence Pullar, was moved by Mr. Horne, seconded by Mr. Peach, and carried unanimously.

The proceedings on Monday afternoon opened with the report of a Committee—consisting of Sir T. H. Holdich, Colonel G. E. Church, Mr. E. G. Ravenstein and Mr. H. N. Dickson—which was appointed at the Bradford meeting to draw up a scheme for the survey of British protectorates, particularly in Africa. The Committee specially urges the importance of laying down a main triangulation so as to provide fixed points from which local surveys by explorers and others may begin, and of providing means of training native surveyors and topographers similar to those existing in India, such surveyors to be attached to exploring and similar expeditions as opportunities offer.

An important paper by Dr. R. Bell, of the Geological Survey of Canada, was next read by Mr. Mackinder. This paper dealt with the topography and resources of northern Ontario, or "New Ontario," and described the immense region lying north-west of the line of Lake Nipissing and the French River. The paper was accompanied by material for the construction of an adequate map of the district, which has not hitherto been represented with any detail.

Mr. A. Lawrence Rotch described some results of the exploration of the upper strata of the atmosphere by means of kites, and discussed specially the application of the method at sea. On land the wind is sometimes insufficient to raise the kites, but on board a steamship the artificial wind due to the motion of the vessel obviates this difficulty, and by altering the course relatively to the direction of the wind the action of the wind on the kite can be regulated to a very considerable extent. Successful experiments have been made at sea on board an Atlantic liner, and the value of extended investigations in the tropics, made from a ship which could be specially detailed for the purpose, can hardly be overestimated. The Association has appointed a strong Committee, with a money grant, to cooperate in these experiments.

The report of the Committee on changes of the land-level of the Phlegræan Fields, drawn up by Mr. Günther, was presented. Mr. Günther's work being still in progress, the report was of a preliminary nature, but it is satisfactory to note that the materials for the investigation have proved more valuable and abundant than was anticipated.

On Tuesday morning Mr. W. N. Shaw, F.R.S., exhibited a complete series of the weather maps published daily by various countries. Most of these bore the date January 1, 1901; others June 1, 1901. The list is interesting as showing the position of this branch of meteorology at the beginning of the twentieth century:—Austria, Bavaria, Belgium, British Isles, Denmark, France, Germany, Holland, Italy, Portugal, Russia, Saxony, Spain, Switzerland, Algeria, Australasia, Canada, India, Bay of Bengal, Japan, Mexico, United States, Roumania.

The rest of the morning was devoted to papers on the Antarctic expeditions. Dr. J. Scott Keltie described the organisation and equipment of the National Antarctic Expedition, and Dr. H. R. Mill gave an account of the voyage of the *Discovery* as far as Madeira, to which point he accompanied the vessel for the purpose of working out the details of the meteorological and oceanographical routine. Mr. W. S. Bruce then read a paper on the methods and plans of the Scottish National Antarctic Expedition, in which he announced that sufficient funds had been subscribed, entirely by Scotsmen, for one complete year's work in the Antarctic. It is proposed to purchase a whaler of about five hundred tons, and to leave this country in about a year's time. The ship will carry a scientific staff of five, five officers, and a crew of twenty. An attempt will be made to push as far south as possible in the Weddell Sea, and the deep reported by Ross in lat. 68° S., long. 13° W., will be specially investigated. The expedition will confine itself almost entirely to marine work, and it is not intended to winter in the ice.

In the afternoon Mr. H. Yule Oldham read a paper on the experimental demonstration of the curvature of the earth's surface. Mr. Yule Oldham has repeated Wallace's Bedford level experiment on the old Bedford River between Welney Bridge and Denver Bridge, a perfectly straight stretch of six miles. A mark was set up midway between the bridges, at the same height above water level as marks on the two bridges, and found to stand six feet above the line of sight. Records of the experiment have been obtained by the use of a special telephotographic lens.

Dr. R. Logan Jack then gave an account of an expedition in Western China, in which the Chengtu Plain was crossed five times, and a good deal of mapping done of the margins of the plain, and the courses of the rivers reaching it from the north. At the Maha gold mines the party received information of the massacres at Pekin, and were advised to make for Burma. Bhamo, in Upper Burma, was reached after many difficulties.

A paper, by Mr. Archibald Little, on the Crux of the Upper Yang-tse, was read by Mrs. Little. The paper contained an extremely graphic account of an ascent of the river during the flood season, and the condition of the country and of river navigation was compared with that obtaining during the winter.

The last paper was by M. Galeron, designer of the great celestial globe at the Paris Exhibition, on the representation of the heavens in the teaching of cosmography. After pointing out the difficulty experienced by the student in realising the apparent positions and motions of the heavenly bodies from a study of the ordinary celestial globe, in which the celestial sphere was represented as seen from the "outside," M. Galeron exhibited and described an apparatus in which a celestial globe is made of thin muslin, and sufficiently large for the head of the observer to be placed at the centre. The apparatus, which can be constructed very simply and cheaply, enables the chief phenomena to be demonstrated with great clearness.

It is noteworthy that the Artisan's Lecture this year, although geographical, was not an account of travel and exploration, but an exposition of the application of geographical principles. In his lecture on "The Movements of Men by Land and Sea," Mr. Mackinder showed how the progress of civilisation has been affected by the configuration of the Earth's surface, and pointed out the profound changes going on in political and social life under our eyes, as the result of the development of the great ocean lines of communication and of the transcontinental railways. The lecture was a perfect illustration of the aims and methods of the "new geography," and should do much to make those better understood and appreciated.

EDUCATIONAL SCIENCE AT THE BRITISH ASSOCIATION.

THOUGH the new Section of the British Association was only appointed for a year, the success of the meetings at Glasgow was of so decided a character that the Section will probably become a permanent part of the Association. It can scarcely be said at present that an educational science exists, but the statement of methods and results, and the discussion of the relationships between principles and practice, apart from all political considerations, should do something to organise the conclusions of people who have given serious attention to educational problems. The Section will exert the greatest influence in connection with scientific studies; and there is no reason why it should not lead to improvements in methods of teaching as valuable as those which have been produced by the scheme for a course of work in chemistry, drawn up by Dr. H. E. Armstrong for the British Association Committee on the methods of teaching chemistry. It is not too much to say that this scheme started a revolution which gathers strength every day. The system of science instruction by didactic methods still exists in places, but only because the machinery for carrying on the work on more rational principles has not been obtained. Wherever the object is education, the methods of research have been introduced, and it is recognised that real scientific knowledge can only be gained by individual experience.

Educational Experiment and Research.

Sir John Gorst accepted the principle of research in education in his address as president of the Section, and Dr. Armstrong emphasised it in an early paper. The power of research, the art of acquiring information for oneself, must, he pointed out, be cultivated in all because it is the power on which advance in life depends. The chief work of the Section will be to teach this doctrine, and impress it upon the teachers. A science of education must be shaped, and a national programme must be constructed in which research methods are encouraged and teachers are trained to have sympathy with them. The humanists must enter into an alliance with the naturalists, and the union should take place on equal terms. At present our educational system is entirely one-sided. The schools still at best suffer science; they do not love it and the old universities do not even regard it as a necessary element of culture.

Reform will be brought about by the development of workshop and laboratory methods. The experimental method of teaching is adapted to the curiosity and activity of the average boy, and should be the basis of instruction at the earliest stages. Prof. L. C. Miall gave strong support to the experimental method, which he described as the most complete embodiment of the methodised art of trying, of ignoring failures and improving successes, and perpetually going on until the goal was reached. This is the habit it is desired to set up and which will take an important place in future educational work. Sir Michael Foster emphasised the view that science is not learnt in the lecture room, but in the laboratory. The first aim should be to teach a boy to think, and this can be done by practical work properly arranged. It has been stated over and over again that pupils who have been prepared by the older learning take to science more readily when they are brought to it than those who have been trained from the very beginnings in science. This, Sir Michael said, was easy to understand, because teachers in the humanities have been trained to teach for generations, while men of science are only now beginning to learn how to teach.

Methods of teaching are of great importance, and the British Association can be the means of producing improvements in them. Prof. H. L. Withers, however, in a paper on the scope of educational science, expressed the opinion that before deciding how this or that subject should be taught it is desirable to formulate a theory of the curriculum, that is, to arrive at some conclusion as to the proportional value of subjects. Mr. P. A. Barnett also took this view, the main argument of his paper being that the criterion of success in education must be, not what people have been taught to do or to make, but what they are and how they bear themselves in all the relationships of life. But the educational value of a subject even considered from this point of view depends upon the scope of the subject and the methods of teaching, so that a reasonable curriculum cannot be drawn up until a decision has been arrived at as to what is implied by the name of each subject.

As instances of differences of opinion as to what should be included in a subject and how the subject should be taught, the discussions on the teaching of elementary mathematics and of botany may be cited. In each case a whole morning was devoted to the expression of expert opinion and the statement of experience in relation to the subject under discussion. For the discussion of the former subject, a joint meeting was arranged with the mathematical department of Section A, and for the latter a joint meeting was held with the Section of Botany.

The Teaching of Mathematics.

In urging a reform of mathematical teaching, Prof. Perry remarked that he would teach mathematics—at all events advanced mathematics—in different ways to different students. In any case he thought the system of teaching boys elementary mathematics as if they were all going to be pure mathematicians must be altered. We taught all boys what is called mathematical philosophy that we might catch in our net the one demigod, the pure mathematician, and we did our best to ruin all the others. In his experience there was scarcely any man who might not become an advancer of knowledge, and the earlier the age at which you gave him the chances of exercising his individuality the better. Educate through the experience already possessed by a boy; look at things from his point of view—that is, lead him to educate himself. Through his whole mathematical course let him be taught through his own experiments, and do not call it waste of time to plot the stream lines, for example, after the algebraic academic answer of a problem has been arrived at. The unpractical nature of mathematical teaching, he held, caused men to leave common sense out of their teaching, and he instanced the great continental Polytechnics, where an elaborate course of many months, or a year, was often devoted to a subject, of which the general principles could be grasped in a practical course of a few weeks.

All advocates of orthodox methods seemed willing to sacrifice every form of usefulness of mathematics to the mind-training inherent in a perfect logical system—a huge complex deduced logically from simple fundamental truths. Where would be the harm in letting a boy accept the truth of many propositions of the first four books of Euclid, partly by faith, partly by trial; of giving him the whole fifth book by simple algebra; and in letting him assume the sixth book as axiomatic? He would allow him, in fact, to begin his severer studies where he was now in the habit of leaving off; and would let him put aside much more than is usually done, so that he would get quickly to the solution of partial differential equations and other useful parts of mathematics. He had been speaking of the training of the mathematician, and he might be wrong; but as to the educational training of the man who was to use his mathematics in the study of pure and applied physical science, he had no doubt whatever of the importance of skipping judiciously in all early mathematic work. In these days all men ought to study natural science, and in such study they required to have the knowledge of algebraic formulæ and the power to use them; to be familiar with the use of logarithms in computation; with the use of squared paper, and with the methods of the calculus. He held that dexterity in these is learned by quite young boys, and he felt sure that such dexterity could not hinder, and could only further, the mathematical study of the exceptionally clever student.

Mathematics was a powerful weapon to unlock the mysteries of Nature. If a man knew how to use the method, that would be enough; he could leave to others, who delight in that, the forging and complete study of the weapon. The average young engineer might be made to possess a power of using the methods of mathematics, which would be as easy to him as reading or writing or using any hand tool—a power which would never grow rusty, because it would be exercised every day of his life; and his present hatred of mathematics and theory of engineering was leading to disaster. Higher mathematics had become a very useful thing. As in the case of all other generally useful things, the complete study of its philosophy in the orthodox manner was not a necessary part of the school or college curriculum. In concluding his remarks, Prof. Perry defended himself against the charge which his engineering friends had brought against him, that he had an exaggerated notion of the importance to all men of possessing a love for mathematics.

The discussion upon the paper was commenced by Prof. Hudson. He said that a too common fault in teaching mathematics consisted in allowing the pupil to learn by heart propositions, formulæ and rules, instead of using them as a means of training the reasoning powers. He trusted that Prof. Perry did not really wish to recommend that method, but he was afraid that its advocates might quote Prof. Perry in their support. Elementary teaching should be so conducted as to prepare for more advanced teaching; nothing should have to be unlearnt. Geometry should be based on the observation and handling of models of solid figures, and thus could be begun at a much earlier age than was generally supposed. Prof. Forsyth criticised the vehemence of the attack which Prof. Perry had made upon the mathematician while sympathising to a considerable extent with his aims. He pointed out that subjects do not necessarily progress on the lines of direct usefulness, and that very many of the applications of the theories of pure mathematics had come many years—sometimes centuries—after the discoveries themselves; the weapon had lain ready to hand, but the man had not been there to use it. He also indicated briefly his views on the teaching of elementary mathematics, and advocated the inclusion of a course on practical geometry early in the pupil's career. With this suggestion, that the pupil should be led to pure geometry only after he had been accustomed to handle and to work with the figures with which geometry is concerned, all the subsequent speakers cordially agreed. Prof. Forsyth further desired to point out the need of a proper system of training teachers so that when they began their profession they would not have to devote their time to practising upon their earliest pupils the method that happened to suit their own particular temperament. Major MacMahon—the president of Section A—joined in the discussion, but confined his remarks to the subject of elementary teaching without entering upon the more important questions raised by the address, which he had already dealt with in his opening address to the Section. Prof. Rücker said that there seemed to be a general agreement among all the speakers that, in the case at all events of the younger children, the teacher ought to approach the subject as far as possible from the concrete side. He also held, with Prof. Perry, that a somewhat rapid advance was advisable in the first case, the various qualifications with which the general statements had to be guarded being entered upon later. While not attacking the system of examinations—which had come in for severe criticism by other speakers—he considered that it had its weak points, but that it was a necessary part of our educational apparatus. Prof. Silvanus Thompson and Prof. Henrici were in entire accord with Prof. Perry; and the latter expressed the hope that qualified mathematicians would prepare text-books upon the lines laid down in the address. Prof. Everett pointed out the need of distinguishing between technical and liberal education, and Prof. Miall criticised the system in which the needs of the pupil and teacher were sacrificed to the demands of the examiner and inspector. Mrs. W. N. Shaw spoke upon the bearing of the discussion on the education of girls; and there also joined in the debate, Mr. J. Parker Smith, M.P., Prof. Greenhill, Prof. Alfred Lodge, Prof. Minchin, Mr. E. M. Langley, and others.

An immediate result of Prof. Perry's address has been the appointment of an influential committee of the Association, with Prof. Forsyth as president and Prof. Perry as secretary, to report upon improvements that might be effected in the teaching of mathematics.

The Teaching of Botany.

The joint discussion on the teaching of botany was held in the rooms of Section K, Prof. Bayley Balfour being in the chair. Mr. Harold Wager introduced the discussion by reading a paper on the teaching of botany in schools. He said that more attention should be paid to methods of teaching if the subject was to take its proper place in the school curriculum as a part of the general scientific training. Too much time should not be spent in mere descriptive work; and the use of the compound microscope should not be encouraged. The right selection of topics was important. Such subjects as experimental plant physiology, the structure and germination of seeds, and the structure and function of the flower were specially to be commended. A good grip of fundamental principles and not an imperfect acquaintance with a vast number of facts was wanted in school teaching.

Prof. Bower read a paper on the teaching of botany in universities. He also urged that the use of the microscope in schools should not be allowed. It should be left to the university course. Thoroughness in special branches should be aimed at with advanced students, not encyclopædic knowledge. Method was far more important than mere information. Advanced students should be left to work independently as much as possible. Research should be encouraged, but futile investigations were a mistake. Stress should be laid upon writing up the results of any piece of work in good literary form.

In the subsequent discussion, Prof. Miall said that in his elementary teaching at the Yorkshire College the laboratory work was the most important part of the work. Lectures were not given, but after a period in the laboratory a discussion on the facts observed took place in the lecture room, and the students were expected themselves to give an account of their work. They very soon learnt to express themselves clearly and easily, and had little difficulty in passing examinations. Prof. Marshall Ward agreed that observations formed a very important part of elementary botany, and children could be taught to reason from facts observed. With advanced students research was a powerful stimulus in developing interest in the subject. Prof. Withers believed that the study of science might well begin with natural history. Chemistry and physics should then be taken, and such a subject as botany might again be taken up in the higher forms. But as a training in scientific method he thought the value of botany was often extremely small.

Prof. Armstrong considered that more attention might be given to systematic botany, and science altogether should be taken more seriously in schools, and at least half the school time should be given to practical work. Chemistry and physics, as well as botany, were required in order to give the student a good knowledge of scientific method. Dr. D. H. Scott said that there was often too much specialisation in the syllabuses drawn up for elementary classes. His experience as an examiner had shown him that the subject could be easily crammed without developing any real knowledge of the subject. Dr. Kimmins gave the opinion, as the result of his experience, that botany was often very badly taught in schools because of the want of properly trained teachers. He thought it was a pity that there was a tendency to replace it altogether by physics and chemistry.

Sir John Gorst said that it seemed to him that one of the best science subjects for purposes of general education was botany, especially for rural schools. The provision of laboratories and apparatus was a difficulty. Perhaps the County Councils might help with these. Properly trained teachers were required, and the subject should have attention in Training Colleges. Too many rural teachers at the present time were not properly qualified to give simple lessons in botany.

The chairman in closing the discussion said that it had been of great interest, and he felt that improvement would take place as soon as a good supply of properly trained teachers could be obtained.

Organisation and Administration.

The other subjects dealt with in the Section belong more to the organisation and administrative side of education than to the aims, scope and methods of science teaching, so a brief mention of them will be sufficient in these columns. Sir Henry Roscoe introduced the subject of the organisation of technical and secondary education, and in commenting upon it Sir Michael Foster said that whatever legislation was brought forward it was to be hoped that no distinction would be made between primary and secondary education. Sir Philip Magnus spoke in favour of the unification of educational effort by the creation of local authorities to be responsible for education in their areas. A paper by the Bishop of Hereford on the influence of the universities and examining bodies upon the work of schools contained a plea for the recognition of science and modern languages as substitutes for Greek in Responsions. It was pointed out that the existing requirement of Greek from every candidate desiring to enter the older universities, together with the accompanying exclusion of modern languages and science, practically dissociates the whole class of modern schools or modern departments in schools from direct university influence, and the effect is found to be specially unfortunate in the modern departments of the large secondary schools. The paper will be printed in full by the Association. Among other subjects discussed were commercial education, and the mechanism of education in Scotland. Dr. J. H. Gladstone also read his annual report on the teaching of science in elementary schools, hitherto presented to the chemistry section, but there were few other papers, the system adopted in the arrangement of the programme being to accept only one or two papers for each meeting, and these to be on definite topics requiring discussion. By this means attention was concentrated upon particular aspects of educational work instead of being directed this way and that by a variety of papers. The system has worked so successfully that it will probably be followed at future meetings of the Section.

FORTHCOMING BOOKS OF SCIENCE.

Mr. Félix Alcan (Paris) gives notice of:—"Les maladies de l'orientation et de l'équilibre," by Prof. J. Grasset; "Manuel d'Histologie pathologique," by Profs. V. Cornil and L. Ranvier, illustrated, tome second.

Among Mr. Edward Arnold's forthcoming books are:—"The Balancing of Engines," by Prof. W. E Dalby, illustrated; "A Handbook on Fermentation and the Fermentation Industries," by Charles G. Matthews, illustrated; "Human Embryology and Morphology," by Dr. A. Keith, illustrated; "A Text-Book of Zoology," by G. P. Mudge, illustrated.

Messrs. George Bell and Sons give notice of:—"Elementary Science," by D. E. Jones and Dr. D. S. Macnair; "Inorganic Chemistry," by Prof. James Walker, F.R.S.; "An Introduction to the Comparative Anatomy of Animals," by Dr. G. C. Bourne, vol. ii.:—*The Coelomata*; "Elementary Differential Calculus," by Prof. A. Lodge, with an introduction by Prof. Oliver J. Lodge, F.R.S.; "An Elementary Treatise on Cubic and Quartic Curves," by A. B. Basset, F.R.S.

Messrs. A. and C. Black promise:—"A Treatise on Elementary Statics" (for the use of schools and colleges), by W. J. Dobbs; "New Descriptive Geographies: Africa, Central and South America, North America," edited by Dr. A. J. Herbertson and F. D. Herbertson.

Messrs. Blackie and Son, Ltd., will issue:—"The World of Animal Life, an Introduction to the Wonders of the Animal World," illustrated.

In the list of the Cambridge University Press we notice:—"Fables and Folk Tales from an Eastern Forest," collected and translated by Walter Skeat, illustrated; "Mathematical and Physical Papers," by Sir G. G. Stokes, F.R.S., vol. iii.; "Scientific Papers," by Lord Rayleigh, F.R.S., vol. iii. It is expected that the work will be completed in four volumes. "The Electrical Properties of Gases," by Prof. J. J. Thomson, F.R.S.; "Electric Waves," being an Adams Prize Essay in the University of Cambridge, by H. M. Macdonald; "A Treatise on Determinants," by R. F. Scott. A new edition by G. B. Mathews, F.R.S.; "The Algebra of Invariants," by J. H. Grace and A. Young; "A Primer of Botany," by F. F. Blackman; "Zoological Results based on material from New Britain, New Guinea, Loyalty Islands and elsewhere, collected during the years 1895, 1896 and 1897," by Dr. Arthur Willey. The entire work will be completed with the publication of part vi., which will be issued during 1901, and will contain Dr. Willey's monograph on *Nautilus* and other articles, including an account of the Ascidians by Prof. W. A. Herdman, F.R.S. "Reports of the Anthropological Expedition to Torres Straits by the Members of the Expedition," edited by Prof. A. C. Haddon, F.R.S., vol. ii.:—*Physiology and Psychology*. It is expected that the work will be completed in five volumes. "Biometrika. A Journal for the Statistical Study of Biological Problems," part i.; "The Fauna and Geography of the Maldive and Laccadive Archipelagoes," being the account of the work carried on and of the collections made by an expedition during the years 1899 and 1900 under the leadership of J. Stanley Gardiner, part i. of vol. i.; "Index Nominum Animalium," compiled by C. Davies Sherborn under the supervision of a committee appointed by the British Association and with the support of the British Association, the Royal Society and the Zoological Society, vol. i. (1758–1800); "Fossil Plants," a manual for students of botany and geology, by A. C. Seward, F.R.S., vol. ii.; "Electricity and Magnetism," by Dr. R. T. Glazebrook, F.R.S., "Hegelian Cosmology," by J. McT. E. McTaggart; "Essays on Educational Subjects," by Prof. S. S. Laurie.

Messrs. Cassell and Co., Ltd., will publish:—"The Earth's Beginning," by Sir R. S. Ball, F.R.S., illustrated; and new editions of:—"Tumours, Innocent and Malignant, their Clinical Characters and Appropriate Treatment," by J. Bland Sutton, illustrated; "Surgical Applied Anatomy," by Sir Frederick Treves, K.C.V.O., assisted by Dr. Arthur Keith, illustrated.

Messrs. W. and R. Chambers, Ltd., announce:—"The Nineteenth Century Series," in which we notice "Medicine, Surgery and Hygiene in the Century," by Dr. E. H. Stafford; "Discoveries and Explorations of the Century," by Prof. Charles G. D. Roberts; "Inventions of the Century," by William H. Doolittle; "Progress of Education in the Century," by James Laughlin Hughes and Dr. Louis R. Klemm; "Progress of Science in the Century," by Prof. J. Arthur Thomson.

Among the forthcoming works of Messrs. Chapman and Hall, Ltd., we see:—"Steam Boiler Economy; a Treatise on the Theory and Practice of Fuel Economy in the Operation of Steam Boilers," by William Kent, illustrated; "Elevation and Stadia Tables, for obtaining Differences of Altitude for all Angles and Distances, Horizontal Distances in Stadia Work, &c., with all necessary Corrections, &c.," by Arthur P. Davis; "Specifications for Steel Bridges," by J. A. L. Waddell; "A Manual of Assaying; the Fire Assay of Gold, Silver and Lead, including Amalgamation and Chlorination Tests," by Prof. Alfred Stanley Miller, illustrated; "High Temperature Measurements," by Prof. H. Le Chatelier and O. Boudouard, translated by George K. Burgess, illustrated; "Mechanical Drawing," by Lieut. Commander F. W. Bartlett, illustrated; "Practical Workshop Mechanics," by Wallace Bently; "The Human Figure in Motion; an Electro-photographic Investigation of Consecutive Phases of Muscular Actions," by Eadward Muybridge, illustrated; "Intermediate Practical Physics; a Manual for the use of Intermediate and Preliminary Scientific Students," by John B. Wilkinson; and new editions of "Notes on Thermodynamics," by H. W. Spangler, part i.; "A Text-book of Mechanical Engineering," by Wilfrid J. Lineham, illustrated.

Messrs. J. and A. Churchill's list contains:—"A Manual on Anatomy," by the late Prof. Alfred W. Hughes, edited by Prof. Arthur Keith; "Clinical Essays and Lectures," by Howard Marsh; "Gynæcological Pathology," by Dr. Charles Hubert Roberts, illustrated; "The Bacteriological Examination of Water," by Major Horrocks; "Serum-Therapy," by Prof. R. T. Hewlett; "A Text-Book of Clinical Medicine," by Dr. T. D. Savill; "A Hand-Book of Nursing, Medical and Surgical," by Dr. Hadley; "Elementary Ophthalmic Optics, including Ophthalmoscopy and Retinoscopy," by J. Herbert Parsons; vol. 4 of Groves' and Thorpe's "Chemical Technology"; "Electric Lighting and Photometry," by W. J. Dibdin and G. E. Cooke; and new editions of:—"A Manual of the Practice of Medicine," by Dr. Frederick Taylor; "A Text-Book of Medicine," edited by Dr. Pye-Smith, vol. i.; "Chemistry, Inorganic and Organic," by Prof. John Millar Thomson and Arthur G. Bloxam; "A Short Manual for Monthly Nurses," by Dr. Cullingworth; "A Simple Method of Water Analysis," by Dr. John C. Thresh; "The Pharmacopœia of the Throat Hospital"; "Dissection Outlines for use with Morris's Treatise on Anatomy."

The Clarendon Press announces:—"Micro-Anatomy," by Gustav Mann.

Messrs. J. M. Dent and Co. announce:—"A Primer of Physiology," by Dr. Alex. Hill; "Northern Mythology," by Prof. Kaufmann; "Beautiful Birds," by Edmund Selous.

Messrs. Duckworth and Co. will publish:—A new edition in one volume of "The Country Month by Month," by J. A. Owen ("A Son of the Marshes") and Prof. G. S. Boulger, with Notes by the late Lord Lilford.

Mr. Gustav Fischer (Jena) announces:—"Abhandlungen, Geologische und Palæontologische," edited by E. Koken, band v. heft 1; "Geologie der Radstädter Tauern," by Prof. F. Frech, illustrated; "Zur Lehre von der Blutzirkulation in der Schädelhöhle des Menschen, namentlich unter dem Einfluss von Medikamenten," by Dr. Hans Berger; "Fauna Arctica," edited by Dr. Fritz Römer and Dr. Fritz Schaudinn, zweiter band, erste lieferung; "Die Dipsomanie," by Dr. Robert Gaupp; "Die Malaria," by Battista Grassi, zweite vermehrte auflage; "Handbuch der Geschichte der Medizin," edited by Prof. Max Neuburger and Julius Pagel, erste lieferung; "Das Agglutinationsphänomen," by Dr. Fritz Köhler; "Topographischer Atlas der medizinischen Diagnostik," by Prof. Ponfick, zweite lieferung; "Handbuch der Hygiene," edited by Dr. Th. Weyl, erster supplementband, erstes heft; "Bedeutung eines systematischen Studiums des Skleroms," by Dr. von Schrötter; "Lehrbuch der vergleichenden Entwickelungsgeschichte der wirbellosen Thiere," by Profs. E. Korschelt and K. Heider, allgemeiner teil; "Technische Mykologie," by Prof. F. Lafar, zweiter band, erste lieferung; "Normentafeln zur Entwickelungsgeschichte der Wirbeltiere," edited by Prof. Dr. F. Keibel, drittes heft, illustrated; "Tropenhygiene mit spezieller Berücksichtigung der Deutschen Kolonien," by Prof. F. Plehn; "Die Bakterien," by Drs. J. Schmidt and Weis, illustrated.

The announcements of Messrs. Charles Griffin and Co., Ltd., include:—"Trades' Waste, its Treatment and Utilisation, with Special Reference to the Prevention of Rivers' Pollution," by W. Naylor; "The Metallurgy of Steel," by F. W. Harbord, illustrated; "Elementary Coal-Mining, for the Use of Students, Miners, and others preparing for Examinations," by George L. Kerr, illustrated; "A Dictionary of Textile Fibres," by William I. Hannan, illustrated; "Sanitary Engineering, a Practical Manual of Town Drainage and Sewage and Refuse Disposal," by Francis Wood, illustrated; "Ferments and their Action, a Text-book on the Chemistry and Physics of Fermentative Changes," by Dr. Carl Oppenheimer, translated by C. Ainsworth Mitchell; "Tables and Data for the Use of Analysts, Chemical Manufacturers, and Scientific Chemists," by Prof. J. Castell-Evans, in 2 vols.; "A Text-Book of Physics," by Prof. J. H. Poynting, F.R.S., and J. J. Thomson, F.R.S., illustrated, introductory volume on *Properties of Matter*; "Diseases of the Organs of Respiration, an Epitome of the Etiology, Pathology, Diagnosis and Treatment of Diseases of the Lungs and Air Passages," by Dr. Samuel West, illustrated; "Official Year-Book of Scientific and Learned Societies of Great Britain and Ireland," eighteenth annual issue.

Mr. W. Heinemann's list includes:—"The Play of Man," by Prof. Karl Groos, translated with the author's cooperation by Elizabeth L. Baldwin; "The Regions of the World," a series of twelve volumes descriptive of the physical environment of the nations, edited by H. J. Mackinder:—"Britain and the British Seas," by the Editor; "The Near East," by D. G. Hogarth; "Western Europe and the Mediterranean," by Elisée Reclus; "Central Europe," by Dr. Joseph Bastoch; "Scandinavia and the Arctic Ocean," by Sir Clements R. Markham, F.R.S.; "The Russian Empire," by Prince Kropotkin; "Africa," by Dr. J. Scott Keltie; "India," by Colonel Sir Thomas Holdich; "The Far East," by Archibald Little; "North America," by Dr. Israel C. Russell; "South America," by Dr. John C. Branner; "Australasia and Antarctica," by Dr. H. O. Forbes.

Mr. H. K. Lewis's list is as follows:—"A Handbook of Bacteriological Diagnosis for Practitioners, including Instructions for the Clinical Examination of the Blood," by Prof. W. d'Este Emery, illustrated; "Transactions of the Dermatological Society of Great Britain and Ireland," vol. vii.; and new editions of:—"Elements of Practical Medicine," by Prof. A. H. Carter; "The Sanitary Inspector's Handbook," by Albert Taylor, illustrated; "Rough Notes on Remedies," by Dr. William Murray.

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Messrs. Sampson Low and Co., Ltd., promise:—"The

Nordrach Treatment for Consumptives in this Country," by James Arthur Gibson; and a new edition of "The Student's Chemistry," by R. L. Taylor.

Among the announcements of Messrs. Macmillan and Co., Ltd., we notice:—"The Sherbro and its Hinterland," by T. J. Alldridge, illustrated; "The Scientific Memoirs of Thomas Henry Huxley," edited by Sir M. Foster, K.C.B., F.R.S., and Prof. E. Ray Lankester, F.R.S., in 4 vols., vol. iv.; "Atlas of Practical Elementary Zootomy," being a revised edition of the zoological portion of the "Atlas of Practical Elementary Biology," by Prof. G. B. Howes, F.R.S., with a preface to the first edition by the late Prof. T. H. Huxley, P.C., F.R.S.; "The Scenery of England and the Causes to which it is due," by the Right Hon. Lord Avebury, F.R.S., illustrated; Macmillan's Manuals of Medicine and Surgery: "A Manual of Medicine," edited by Dr. W. H. Allchin, vol. iv. *Diseases of the Respiratory System and of the Circulatory System*, vol. v. *Diseases of the Digestive System and of the Kidneys*; "Assimilation and Digestion," by Sir T. Lauder Brunton, M.D., F.R.S.; "The Climates and Baths of Great Britain," being the Report of a Committee of the Royal Medical and Chirurgical Society of London, vol. ii. *The Midland Counties and Ireland*; "Outlines of Inorganic Chemistry," by Prof. W. Ostwald, translated by Dr. Alex. Findlay; "An Experimental Study of Gases," by Morris W. Travers, with a preface by Prof. William Ramsay, F.R.S.; "Lectures and Essays by the late William Kingdon Clifford, F.R.S.," edited by Leslie Stephen and Frederick Pollock, with an introduction by F. Pollock, third edition, in 2 vols.; "Philosophy, Its Scope and Method," a course of introductory lectures by the late Prof. Henry Sidgwick; "The Growth of Hegel's Logic," by J. B. Baillie; "Mind in Evolution," by L. T. Hobhouse; "Texts for a Course of Elementary Lectures on the History of Greek Philosophy," edited by Dr. Henry Jackson; "Mammals," by F. E. Beddard, F.R.S. (being vol. x. of the Cambridge Natural History); "Insect Life, Souvenirs of a Naturalist," by M. J. H. Fabre, translated from the French by the Author of "Mademoiselle Mori," with a preface by Dr. David Sharp, F.R.S., illustrated; "The Mystic Rose, a Study of Primitive Marriage," by A. E. Crawley; "An Elementary Treatise on the Calculus," by Prof. George A. Gibson; a new edition of "The History of Human Marriage," by Dr. Edward Westermarck, with preface by Dr. A. R. Wallace, F.R.S.; "Upland Game Birds," by Emerson Hough, illustrated; "Salmon, Trout," by Dean Sage and A. Nelson Cheney, illustrated; "The Deer Family," by the Hon. Theodore Roosevelt, T. S. Van Dyke, and H. G. Stone, illustrated; "Municipal Engineering and Sanitation," by M. N. Baker; "An Introduction to Celestial Mechanics," by Dr. Forest Ray Moulton; "Elementary Electricity and Magnetism," by Profs. D. C. Jackson and J. P. Jackson, illustrated; "A Primer of Calculus," by Arthur S. Hathaway, illustrated; "The Practical Methods of Organic Chemistry," by Prof. Ludwig Gattermann, a new edition of the authorised translation by Dr. William B. Shober, illustrated; "The Applications of the Kinetic Theory to Gases, Vapours, Pure Liquids, and Solutions," by Dr. William Pingry Boynton, illustrated; "The Protozoa," by Dr. Gary N. Calkins, illustrated; "The Röntgen Rays in Medicine and Surgery, as an Aid in Diagnosis and as a Therapeutic Agent," by Dr. Francis H. Williams, illustrated; "Cyclopædia of American Horticulture," edited by Prof. L. H. Bailey, illustrated, vol. iv., completing the set; "First Lessons in Agriculture," by Prof. L. H. Bailey; "University Text-book of Botany," by Prof. Douglas Houghton Campbell, illustrated; "The Principles of Stock Breeding, the Application of Biological Laws to the Breeding of Domestic Animals (including Poultry), whether for Fancy or Profit," by Prof. W. H. Brewer; "Dictionary of Philosophy and Psychology," edited by Prof. James Mark Baldwin, with an international body of collaborators, in 3 vols.; "A Student's History of Philosophy," by Prof. Arthur Kenyon Rogers; "An Introduction to Psychology," by Prof. Mary Whiton Calkins; "Mental Growth and Control," by Dr. Nathan Oppenheim; "The College Student and his Problems," by Dr. James H. Canfield; "The Child's First Book in Science," by Dr. Edward S. Holden, illustrated.

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Messrs. George Newnes, Ltd., will publish in the Library of Useful Stories Series:—"The Story of Animal Life," by B. Lindsay, illustrated; "The Story of Euclid," by W. B. Frankland.

In the list of Messrs. Kegan Paul, Trench, Trübner and Co., Ltd., we observe:—"Assyrian Language, Easy Lessons in Cuneiform Inscriptions," by L. W. King; "The Book of the Dead, an English translation of the Theban Recension," with supplementary chapters, hymns, &c., and nearly 400 vignettes which do not appear in the larger edition published in 1897, by Dr. E. A. Wallis Budge; and a new edition of "Text-Book of Physiological and Pathological Chemistry," by G. Bunge, translated from the German edition by Florence Starling.

Messrs. G. P. Putnam's list includes:—"Zuni Folk-Tales," by F. H. Cushing, illustrated; "The Home Life of the Wild Birds," by F. H. Herrick, illustrated; and a new edition of "Thinking, Feeling, Doing," by E. W. Scripture, illustrated.

Mr. Grant Richards announces new editions of "Colin Clout's Calendar," by Grant Allen; and "Logic, Deductive and Inductive," by Carveth Read.

Messrs. Rivingtons announce:—"Chinese Turkestan, with Caravan and Rifle," by Percy W. Church; "Rivingtons' Junior Mathematics," by H. G. Willis, comprising Arithmetic, two parts; Algebra, two parts.

Messrs. F. E. Robinson and Co. will issue:—"Wild Sport in the Outer Hebrides," by C. V. A. Peel.

Mr. Walter Scott announces:—"History of Geology and Palæontology to the End of the Nineteenth Century," by Prof. Karl von Zittel, translated by Dr. M. M. Ogilvie-Gordon, illustrated; "The Study of Religion," by Prof. Morris Jastrow, jun.

Messrs. Seeley and Co., Ltd., promise:—A new and enlarged edition of "The Chemistry of Paints and Painting," by Prof. A. H. Church, F.R.S.

Messrs. Smith, Elder and Co. call attention to:—"Lectures on Chemical Pathology in its Relation to Practical Medicine, delivered at the University and Bellevue Medical School, New York City," by Prof. C. A. Herter.

Messrs. Sonnenschein and Co., Ltd., have in hand:—"Harlyn Bay and the Discovery of its Prehistoric Remains," by the Rev. R. A. Bullen; Heinze's "History of Contemporary Philosophy," translated by Prof. W. Hammond; Wundt's "Physiological Psychology," translated by Prof. E. B. Titchener; "The Student's Text-book of Zoology," by A. Sedgwick, F.R.S., vol. ii.; "Psychology, Normal and Morbid," by Dr. C. A. Mercier; and new editions of Hertwig's "Elements of Embryology," and Walters' "Sanatoria for Consumptives."

Mr. Fisher Unwin will issue:—"Alcoholism—a Study in Heredity," by Dr. G. Archdall Reid.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A research studentship of 120*l.*, tenable for one year, has been awarded at Emmanuel College to Mr. G. L. Tuck.

THE new pathological laboratory at Oxford is to be opened by Sir William Church on Saturday next.

A NEW science building in connection with Colorado College, and which will cost 300,000 dollars, is in course of construction. Towards the amount required Dr. D. H. Pearsons has contributed 50,000 dollars, and an anonymous donor 100,000 dollars.

THE Calendar of the Royal Technical Institute, Salford, for the sixth session, 1901–2, has reached us, and contains full information respecting the various courses of instruction given at this well-equipped institution.

Science announces that the expenses of a department of anthropology in the University of California will be entirely borne by Mrs. P. Hearst. The department will pay especial attention to the study of the Indians of the Pacific coast.

AMONG recent professorial changes in American universities we notice the following:—Prof. E. M. Wood is to succeed Prof. H. Benner in the chair of mathematics and astronomy of Albion College, Mich., Prof. T. C. Esty will take the place of Prof. Baker as professor of mathematics in the University of Rochester, and Prof. P. Arnold will fill the chair of mathematics in the University of Southern California.

THE annual report of the Glasgow and West of Scotland Technical College has just been issued, and tells of much good work done and progress made during the period under review. The number of students has increased to the utmost capacity of the buildings, and the curriculum has been extended in several directions. After a close inquiry into the standard of instruction, the composition of its staff and the plan of its future operations, the Scotch Education Department and the Treasury have granted to the College a fixed annual subsidy on practically the same conditions as the annual grants to the English University Colleges. The authorities are much embarrassed by the poor class-room and laboratory accommodation, and it is to be hoped, therefore, that the sum required for the proposed building operations will be speedily forthcoming. So crowded is the College that the Governors have been obliged to announce that they are unable to consider any additional applications for admission to quite a number of evening classes.

THE *Alumni Weekly* of the University of Minnesota for September 23 contains an account of the new botanical station which has been built on Vancouver Island for students of botany in Minnesota and the north-west. The seaside station, as it exists, is but a beginning, and many things are required for its suitable equipment, such as a small steam-launch, a steam-pump, a system of water-pipes for fresh- and salt-water, an additional laboratory building and other conveniences; but the start made is an encouraging one. The party of students and others which visited the station during the recent season numbered twenty-nine, and a very successful gathering seems to have been held. The days were spent in studying the products of the shore and forest, and in the evenings brief botanical lectures were delivered by the teachers. The buildings are, it may be mentioned, at present planned to accommodate eighty workers.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 30.—M. Bouquet de la Grye in the chair.—The problem of the dissipation of heat in a thick wall with radiating surface, by M. J. Boussinesq.—Remarks on the formation of acids in plants, by MM. Berthelot and André. It has been found that there is no relation between the total amount of vegetable acids contained in a plant, in the free or combined state, and the amount of acid in the juice extracted from the various parts.—On the engraved and painted figures of the Palæolithic period found on the walls of the cave of La Mouthe (Dordogne), by M. Emile Riviere. A minute description of prehistoric drawings, the existence of which was first indicated in 1895. The cave is nearly filled up with débris of prehistoric man, who inhabited the cave at two distinct epochs, which are clearly distinguished by a stalagmitic layer which separates them. The drawings are of three kinds, simple line engravings, others filled with a brownish-red ochre, and a third a kind of striation of the rock. All, with one exception, represent animals, the most perfect being complete figures of a bison and of a kind of antelope. The wild goat and reindeer are also recognisable.—On differential equations of the second order with algebraical coefficients, by M. Paul J. Suchar.—On the variable state of currents, by M. A. Petot.—The calculation of the heat of volatilisation and heat of fusion of some elements, by M. de Forcrand. The relation $(L + S)/T = (l+s)/T = 30$ between the molecular weight M, the heat of fusion S, the heats of volatilisation and fusion L, l, and the temperature, is applied to the cases of phosphorus, arsenic and selenium.—Nitromannite and nitrocellulose, by MM. Leo Vignon and F. Gerin. It has been previously shown by one of the authors that the various nitro-derivatives of cellulose energetically reduce an alkaline copper solution. It is now shown that penta- and hexa-nitromannite behave similarly. This reducing power is not altogether due to the formation of mannose. Nitromannite, reduced by ferrous chloride, gives a mannite devoid of reducing power. From this point of view it behaves differently from the nitro-celluloses.—The formation of an isatin derivative of albumen, by M. Julius Gnezda. A substance giving the reactions of chlorisatin has been obtained from the products of the reaction between hypochlorous acid and peptone.—On the reproduction and development of *Peripatopsis Blainvillei*, by M. E. L. Bouvier.—On stolonisation in the hydroides, by M. Armand Billard.—The fibrovascular elements of the stem and frond of some Filicineacæ, by MM. C. Eg. Bertrand and F. Cornaille.—On the localisation and dissemination of antimony in the organism, by M. G. Pouchet. The toxic action of antimony and its localisation require doses of antimony much larger than with arsenic, the localisation of antimony being different from that of arsenic. The toxic action of arsenic is not diminished by the presence of antimony, but, on the contrary, appears to be somewhat increased.

CONTENTS.

THURSDAY, OCTOBER 17, 1901.

THE ENGINEERING LABORATORY.

Experimental Engineering. Vol. ii. Testing and Strength of Materials of Construction. By W. C. Popplewell, M.Sc. Pp. viii+404. (Manchester: Scientific Publishing Company, 1901.) Price 10*s.* 6*d.* net.

THERE is no doubt that the most striking feature in the increased provision of means for the scientific training of engineers during the last quarter of a century has been the great development of laboratories equipped for experiment and research in all branches of engineering. While as yet there is no general agreement as to the best avenue to the engineering profession, it is universally admitted that such a training as is possible in a well-arranged laboratory can be made a most valuable adjunct to any system of instruction or apprenticeship. This development alone has created a field for a series of text-books such as that of which the book before us is the second volume, while the fact that it is also intended to meet the needs of the large class regularly engaged in what is known as "commercial" testing serves to widen its scope, without in any way diminishing its value for more strictly educational purposes. The book contains a large amount of useful matter, collected with much discrimination from a great variety of sources, and we have little hesitation in saying that it will in very great measure meet the needs to which we have referred.

In his introduction, Mr. Popplewell explains that he has included a chapter on the mechanics of bodies under test loads, not with the view of instructing the novice in the fundamental parts of the subject, but simply in order to explain briefly the leading principles involved, and to record the formulæ to be afterwards used. Such brief explanations of general principles, however, are almost always unsatisfactory in themselves; it so often happens that in arriving at a simple formula the important matters are those which are omitted, so that the subject is presented to the student in a garb of spurious simplicity. Again, the student, allured by the brevity of such explanations, is strongly tempted to confine his investigation of the principles to the explanatory chapter and to overlook the author's disclaimer. The results of this tendency are only too apparent in the bald proofs so familiar to every examiner in the subject. And further, apart from its expressed limitations, Mr. Popplewell's chapter of theory is in itself in some respects open to criticism.

It is, for instance, important that the measure of a "strain" should be a number representing what may be called the strain-ratio, so that for any elastic deformation we have the simple relation

$$\text{strain} = \frac{\text{stress}}{\text{modulus}},$$

the modulus being the stress which would produce unit strain. We find, however, that while "strain" is correctly defined on p. 14, the very next page presents us with the unhappy equation

$$\frac{\text{stress applied}}{\text{modulus of elasticity}} = \frac{\text{amount of strain}}{\text{original length of the prism}}.$$

The discussion, again, of the relation between E and G, the moduli of elasticity and of rigidity respectively, is cumbersome and might be much simplified, and although it is pointed out that the result (that G is to E as 2 is to 5) depends on assuming that Poisson's ratio has the value 4, which is only partially justified by experiment, this result is quoted on p. 216 as having been deduced in the earlier chapter from purely theoretical considerations. Generally speaking there is a marked lack of elegance about Mr. Popplewell's mathematics; special instances of his cumbersome style may be found on p. 40, and again on p. 160.

On the other hand, he has done well to call special attention to the difference between the twisting moment in a bar in which, the state being entirely elastic, the stress is proportional to the radius, and that in a bar in which, the plastic state having been reached, the stress may be regarded as uniform over the section, a distinction which is sometimes lost sight of in reducing and comparing the results of observation.

The second chapter, a long one, is devoted to the description of testing machines, and the comparison of the advantages and disadvantages of the various types of large machines in general use will be found of great value not only by the works manager or teacher who may require a machine to suit special conditions, but also by the intelligent student, who is only too apt to regard the particular machine, on which it may be his lot to work, as embodying all the virtues, or it may be all the vices, of its kind. Many of the illustrations, particularly the diagrammatic views of different types of machines, are very good, and for a few more of these we could well spare the half-dozen or so of photographs, which have in most cases been taken in a bad light and have all suffered in reproduction. It is a pity to burden a text-book with general views which can be found, reproduced in much better style, in the makers' catalogues.

It were vain to attempt anything like an exhaustive description of the various measuring appliances now in use, as it seems to be a point of honour for each laboratory to design a special type, but Mr. Popplewell gives a short and sufficient account of the more familiar extensometers and gauges. More perhaps might have been said of optical methods of measurement, particularly of appliances depending on the principle of the optical lever, which is now largely used in many laboratories, or embodying a delicate spirit level, of which one instance only, Prof. Unwin's extensometer, is described.

Special chapters are devoted to descriptions of the methods of carrying out various tests in tension, compression, bending and torsion, and of recording and reducing the results, and these chapters are well done. In the account of bending tests we notice no reference to the bending of long rods of small section. Even if these tests are not of importance from the commercial point of view, they are of value in the laboratory from the simplicity of the apparatus and the ease with which the properties of different materials can be compared, and from the fact that elastic displacements large enough to be accurately measured with micrometer eyepieces can be used.

Several torsion machines are described, and the difficulty of obtaining a pure twisting couple is pointed out. It is the case, however, that in many of the torsional machines in ordinary use the method of measuring the torsional deformation is not sufficiently accurate to justify elaborate precautions against bending moments, although it is not difficult to devise quite simple apparatus for making these angular measurements. These simpler means are somewhat overlooked by Mr. Popplewell, but an excellent account is given of the more elaborate and accurate instrument designed by Mr. Coker.

We are glad to find that our author, while describing several of the standard forms of apparatus for taking autographic records, is alive to the fact that these records are of secondary importance so far as the determination of the properties of the material is concerned, although undoubtedly of great use in exhibiting the nature of these properties. In educational testing especially, as indeed in all laboratory work, there is a danger of fostering too great reliance on autographic records, and the supreme value of first-hand observations cannot be too strongly insisted on.

It must suffice here to mention that the sections of the book which deal with the tests of ropes, chains, struts and so on are sufficient for their purpose, that there is a useful account of cement testing, although perhaps enough weight is not allowed to the personal factor in mixing, and that tests of the other materials of building construction are also briefly dealt with. Some account is also given of the effect of varying conditions, such as temperature, annealing, and bending, on the properties of metals. The effect of repeated stress and of reversed stress is dealt with in Chapter xi., and it would add considerably to the practical value of this chapter if a description of some of the standard pieces of apparatus used in making these tests were included. The account of timber testing is somewhat brief, but the general course of such tests is described and some standard determinations are quoted.

In his final chapter Mr. Popplewell has collected and tabulated a large number of determinations of what he calls the strength properties of the various materials considered, and this chapter, which seems both comprehensive and up to date, will undoubtedly be much used for reference by all who have occasion to consider these properties. He also adds a bibliography of books and memoirs.

We find no reference to the microscopic investigation of the structure of metals, a subject which has so much advanced of late years. The subject, indeed, demands a volume to itself, and at present perhaps is more in the province of the metallurgist than in that of the engineer, but its application to the investigation of flaws in structural parts has already given it a practical bearing which ought not to be overlooked.

Throughout the whole volume the need of occasional calibration of any testing machine in ordinary use is not indicated, nor is any description of the methods usually adopted in carrying out such a calibration given. This is a matter of such importance from a practical point of view that we must attribute the omission to inadvertence, and it will no doubt be rectified in another edition. On the whole, notwithstanding the few omissions and defects to which we have thought it necessary to call attention, we heartily commend the book to all who have to do either with the commercial testing of materials or with the management of the testing departments of engineering laboratories.

A NEW SURVEYING INSTRUMENT.

Der Hammer-Fennel'sche Tachymeter-Theodolit und die Tachymeter-kippregel zur unmittelbaren Lattenablesung von Horizontaldistanz und Höhenunterschied. Von Dr. E. Hammer, Professor an der K. Technischen Hochschule in Stuttgart. Mit 16 Figuren im Text und 2 Lithographierten Tafeln. Pp. 52. (Stuttgart: Konrad Wittwer, 1901.)

PROF. HAMMER has long occupied himself with the problem of constructing an instrument which should give the surveyor the necessary data for plotting his work with the least possible difficulty. Indeed, his numerous references to his previous work, and to the criticisms he has from time to time offered on the work of others, make his introduction not a little difficult to read. But, since the history of his work connected with tacheometers is set out with true German completeness, it may be valuable to anyone who is working on similar lines. In 1893 the author began to solve the following problem: to devise a tacheometer-theodolite, by which at one operation and without reading an altitude circle the observer could determine both the horizontal distance and the difference of altitude of a selected spot from the instrument. This problem the author now claims to have satisfactorily solved, and the instrument is on the market; but notwithstanding this long preparation we gather that several small improvements touching the arrangement of the microscopes and the general mounting of the instrument are still contemplated.

The optical part of the instrument consists of a so-called Porro object-glass, in which two lenses are kept at a constant distance from each other. The principal object-glass has a focal length of 350 mm., and the second lens, placed at a distance of 340 mm., 220 mm., giving to the entire system a focal length of 335 mm. The focussing is effected by moving the object-glass, and the eyepiece views a diagram of peculiar construction on which the effectiveness of the instrument depends. No compass or altitude circle is furnished with the tacheometer, but these can be added if it is desired to use the instrument as a transit theodolite or for other purposes. Instead of an altitude circle, a prism is placed at the side of the telescope above the axis, in connection with which is a carefully constructed diagram, arranged to a scale, by which can be shown the amount of tilting given to the telescope. A second prism placed behind the ocular throws an image of the diagram into the field of view, and as the telescope is moved up or down the diagram is moved to the right or left of the field, thus causing the lines of the diagram indicating the amount of inclination to cut the vertical wire in the eyepiece at a different place. The diagram and mechanical adjustments are so arranged that by multiplying the observed displacement of the line from the zero by 20, the difference of altitude in metres will result, while another displacement multiplied by 100 gives the distance. Very great care seems to have been bestowed on the construction of the field diagram on which the accuracy of the instrument must much depend. The correctness of the coefficient could no doubt be effectually checked by the measurement of known distances and of differences of altitude. Some little inconvenience, it would seem, must arise from the fact that the zero of altitude does not correspond with the axis of collimation of the telescope. This displacement of the zero line has been necessitated by the desire to make the instrument available for the measurement of differences of altitude amounting to 30°, and to get the resulting displacement for such elevation it was necessary to use more than the semidiameter of the field. The author discusses the amount of error likely to arise from this cause and puts the result in a tabular form. Very full descriptions of the method of adjustment are given and some very practical remarks are made on the method of using the apparatus.

To judge by the examples that the author has given, the instrument should prove very useful in the hands of an expert. These examples show that in the measurement of a distance of 250 m. an error of about 0·6 m. may be apparent, while the average error in elevation over the same distance, and in which the variation of level amounts to about ± 7°, will amount to a few centimetres.

OUR BOOK SHELF.

Results of Meteorological Observations made at the Radcliffe Observatory, Oxford, in the eight years 1892–99. Edited by Arthur A. Rambaut, M.A. (Dubl. and Oxon.), Sc.D., F.R.S., Radcliffe Observer. Vol. xlviii. Pp. xxiv + 245. (Oxford: J. Parker, 1901.)

THE publication of a collection of meteorological observations made in 1892 may at first sight appear somewhat belated, and as giving promise of but little interest. But observations such as the greater part of those contained in this volume serve two purposes. There is first of all the immediate application of knowledge concerning the atmospheric variations whose usefulness is shown in weather prediction and similar purposes. Some may think that this is the main, if not the only, outcome of meteorological inquiry. But, apart from all ephemeral interests, the maintenance of a continuous record of the behaviour of the atmosphere is of great importance. The study of climatic oscillations throughout long periods is a study that is likely to be attended with great advantage and instruction. The long, costly and laborious series of observations, that are so carefully prosecuted at so many stations, can only be justified by their use in investigations which aim at the primary causes of atmospheric disturbance. The records of the Radcliffe Observatory hold a deservedly high place in such series, both for accuracy and for length of time during which they have been uninterruptedly pursued, and for the purposes of scientific meteorology the value of the present volume is undiminished by the length of time that separates us from the earlier observations. It will take its place among many worthy companions and hand on the history of the variation of climate to those who have the skill to read it.

A feature of great additional interest is given to the present volume by an inquiry into underground temperatures at various depths by means of platinum-resistance thermometers. This inquiry was originated under the direction of the late Mr. E. J. Stone, and has been vigorously prosecuted by the present director. The thermometers are placed at depths varying from six inches to ten feet; a greater depth, which was originally contemplated, being found impracticable owing to the presence of water in the soil. The present inquiry is limited, but precise. It concerns itself with the variation of temperature in dry gravel; and the thermal conductivity of a water-logged stratum, or of one greatly differing in constitution from that here investigated, does not come into consideration. The main conclusion to which the Radcliffe Observer is led in this investigation into the physics of the earth's crust is, that the annual variation of temperature is reduced to 0°·1 F. at a depth of 45·3 English feet, and to 0°·01 F. at 66 English feet. The semi-annual wave has the same limits at 21·4 and 36 feet, respectively. The temperature curves for the separate months of the year on which this result is based are shown graphically in a plate possessing many features of interest.

But of equal, if not of greater, importance is the inquiry into the accuracy of the thermometers themselves and their suitability for such investigations. One gathers that although very considerable difficulty was experienced at the outset, and not unnaturally with a novel kind of apparatus, these thermometers have stood the test with great satisfaction and proved themselves more trustworthy and more convenient than the long-stemmed spirit thermometers ordinarily employed in similar researches, and against which some obvious objections can be urged. The main difficulty in the use of the platinum-resistance thermometer seems to arise from a damp atmosphere affecting the connecting wires and impairing the insulation, but with sufficient precaution the recording apparatus is most sensitive and permanent.

The Telephone System of the British Post Office. By T. E. Herbert. Pp. xi + 218. (London: Whittaker and Co., 1901.) Price 3*s.* 6*d.*

MR. T. E. HERBERT describes the book before us as a practical handbook, and, from certain expressions used in the second chapter, he seems to be one of those practicians who have not overmuch sympathy with theoretical workers. It is not perhaps to be wondered at, therefore, if the preliminary chapters of his book, dealing with the fundamental principles of sound, electricity, magnetism, and telephony are handled in a very unsatisfactory manner. We are afraid that a reader, if he has not already acquired a thorough knowledge of the subject, will be liable to form erroneous impressions. Thus, to give one example, Mr. Herbert states that in an induction coil "the E.M.F.'s generated in the secondary coil are directly proportional to the current variations in the primary." Again, the description of the action of the Bell transmitter is, we are inclined to think, incorrect, as the same mistake is made here of not properly allowing for the time taken over a vibration of the diaphragm.

The greater part of the book is devoted to a detailed consideration of the apparatus and connections used by the Post Office. This would have been greatly improved if more care had been taken with the diagrams. It is a great pity that in a book of this kind, where clearness in the illustrations is so important, the lettering should be in some cases so small as to be unreadable. It is to be regretted, too, that such words as "nextly" and "inoxidible" are allowed places in the text. In spite of the defects, some of which we have tried to point out above, we have no doubt the book may prove useful to telephone engineers who are anxious to be helped over some of their practical difficulties, and are not particular about a clear understanding of the groundwork of their science.

Maps: their Uses and Construction. A Short Popular Treatise on the Advantages and Defects of Maps on Various Projections, followed by an Outline of the Principles involved in their Construction. By G. James Morrison, Memb. Inst.C.E., F.R.G.S. Pp. viii + 110. (London: Edward Stanford, 1901.) Price 5*s.* net.

A BOOK in English on map projections has long been needed, and the present work is a very welcome attempt to meet this need. It may be commended to all who have to deal with geographical questions, and to teachers of mathemathics and practical geometry who wish to find fresh exercises for their pupils.

The volume consists of an introduction, a popular account of eight common projections, followed by another chapter dealing with the same projections in a slightly more advanced manner, and concluding with a discussion of projections of small areas. The popular description is exceedingly lucid, and the style is everywhere clear. The main defects of the book are that it is not sufficiently systematic, its nomenclature is occasionally at fault, the practical constructions in some cases are not the simplest, and the drawing of the diagrams is somewhat careless, so that statements in the text cannot always be verified on the figures. For Lambert's equivalent azimuthal projection, the author says there is no special name, and he calls Lambert's equivalent cylindrical projection simply the cylindrical projection. He omits Bonne's projection and both the Sanson-Flamsteed and Mollweide (Babinet's), all of which should receive some notice even in a popular work.

He rightly insists on the value of gnomonic projections for seamen, and of equivalent projections in our atlases; and desires the production of cheap and simplified globes.

A. J. H.

Smokeless Powder, Nitro-cellulose and Theory of the Cellulose Molecule. By John B. Bernadou, Lieut. U.S.N. Pp. viii + 200. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1901.) Price dollars 2·50.

THIS small work is of an entirely different character to the usual text-books on explosives, the author confining himself mainly to a theoretical consideration of his subject. To all interested in the manufacture or use of modern explosives the book should be of interest, throwing as it does much light on the theory of nitro-cellulose and mixtures containing this body, such as cordite or powders containing metallic nitrates with nitro-cellulose.

The book is divided into two parts, there being four appendices occupying considerably over half the volume. This latter portion is of most interest, for the author has collected together translations of the admirable papers by (1) Vieille, "Researches on the Nitration of Cotton"; (2) Mendeléef, "Pyrocollodion Smokeless Powder"; (3) Bruley, "The Nitration of Cotton" (an extension of Vieille's work). Appendix iv. consists of an abstract of a lecture by the author on the development of smokeless powder.

In the early pages concise definitions and a list of synonyms are given for the various substances dealt with, which avoids much confusion.

Some interesting work is recorded on the behaviour of guncotton at low temperatures. With liquid air it was found to be "not only not an explosive, but practically a non-combustible; while non-nitrated cotton under similar conditions is a violent explosive."

The remarkable action of very low temperatures in effecting solution of nitro-celluloses is dealt with at some length. McNab and others have shown that an insoluble nitro-cellulose becomes soluble in ether-alcohol at $-50°$, and the author shows that these bodies are soluble in ethyl ether under the influence of intense cold, and with the exception of the highly nitrated insoluble variety, they are soluble in absolute alcohol under similar conditions.

Lieut. Bernadou, in the latter part of the book, advances an ingenious theory of progressive impulses in guns when firing nitro-cellulose-nitro-glycerin charges, or colloided nitro-cellulose with metallic nitrates incorporated. With cordite, for example, "conditions point to there being two intervals in the decomposition of the charge, during one of which a maximum quantity of nitro-glycerin, and, during another, a maximum quantity of nitro-cellulose is burning." Finally, there may be a third impulse due to combination of the gaseous products. This latter appears to obtain confirmation from McNab and Ristori's analyses of the products from the materials separately and cordite (*Proc.* Roy. Soc., lvi. p. 8.)

In the space of a short review it is impossible to deal in a satisfactory manner with the author's theory of the cellulose molecule, many points being open to debate. The author's formulæ show four OH groups in the unit molecule $C_6H_{10}O_5$, which necessitates the assumption that on nitration some of these groups are unattached, whereas if the molecule is considered as having only three OH groups the limit of nitration is easily accounted for. Again, we are asked to assume that at low temperatures ethyl alcohol "under strain" has the composition usually associated with methyl ether, and that colloidisation is brought about by half molecules of ether or alcohol (under strain!) combining with half molecules of the nitro-cellulose.

J. S. S. B.

Catalogue of the Collection of Birds' Eggs in the British Museum (Natural History). Vol. i. By E. W. Oates. Pp. xxiii + 252. Illustrated. (London: Printed for the Trustees, 1901.)

WE have received from the Trustees a copy of this carefully compiled and beautifully illustrated volume, which reflects the greatest credit on all concerned in its production, and should prove invaluable to all ornithologists and egg-collectors. As a matter of fact, it is somewhat more than is indicated by its title, for the exquisitely coloured plates illustrate the chief types of egg form and coloration characteristic of the various groups of birds, so that it forms to a great extent a manual of "oology." We do not on the present occasion propose to review the volume in detail, reserving this till the work is completed. It may be mentioned, however, that the work is practically unique of its kind, the only other catalogue of eggs published by the Museum having been issued so far back as 1852, and treating only of British birds.

The Trustees have been well advised in securing the services of Mr. Oates, whose previous experience rendered him peculiarly qualified to undertake this important task. Of late years, owing largely to generous donors, the collection of eggs in the Museum has increased by "leaps and bounds," and is probably quite unrivalled elsewhere. At the present time it includes more than 50,000 specimens; but even this vast number, according to the author, represents only about one-third of the known species of birds. An interesting feature of the volume is the account of the growth of the collection, which forms a large part of the introduction.

With the bare statement that it includes the eggs of the ostrich-like birds, the tinamus, game-birds, hemipodes, sandgrouse, pigeons, rails, grebes, divers, penguins, petrels, auks, and gulls, we take leave, for the present, of a most valuable and instructive volume.

R. L.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Colours of Guillemots' Eggs.

YOUR reviewer, in dealing with Mr. R. J. Ussher's work on the birds of Ireland (see NATURE, November 29, 1900, pp. 101 and 102), had his attention particularly drawn to two statements concerning the eggs of the guillemot. In the first of these, which occurs on p. 364 of his book, Mr. Ussher puts forward the suggestion that "the beautiful varieties of colouring must help each bird to distinguish her egg from others lying near *until they all become stained and soiled*" (the italics are mine). This is certainly a very pretty hypothesis; but is not the earlier part contradicted by the part I have italicised? It is certainly indirectly contradicted by a statement on p. 365, where Mr. Ussher records his belief that when the eggs of the guillemot are found, as they sometimes are, in the nests of cormorants and kittiwakes, "the owners of the nest incubate the mixed clutches, and not the guillemots, for I have noticed (he writes) a kittiwake chase away one of the latter from its nest."

If this be so, may we not doubt the propriety of supposing that a probably not very intelligent bird like the guillemot has a better eye for varieties of egg coloration than the kittiwake or cormorant, which cannot distinguish the strange egg dropped in its nest? And if the guillemot has a keen eye for colour, and if this faculty be as useful to the bird as Mr. Ussher suggests, is it not remarkable that natural selection should have permitted the speedy obliteration by stains and soiling of such important guide-marks? Is it not also remarkable that the guillemot, which, on the above-stated theory, needs distinctive marks to guide her to her own egg, should so easily dispense with these marks when her egg is hatched and her young one, so like its fellow-chicks, stands before her?

Why, again, should each guillemot be provided with a conspicuous private egg-pattern when other sea-birds, her neighbours, have to find their homes without such aid?

We have no right to suppose that the guillemot needs guide-marks to enable her to perform acts which are simple in comparison with those performed by many other birds and mammals. The guillemot's egg is stationary. The young of the fur-seal wanders widely amongst thousands of its similar brethren, yet its mother, even after days of absence, never fails to recognise it and will be satisfied with no other. So, too, travellers in the Antarctic tell us that the penguins[1] of that region have no trouble in finding their own offspring. There is no need, however, to multiply instances of what is a perfectly well-known faculty in gregarious animals.

I cannot think that this theory of Mr. Ussher's, so easily made and proportionally difficult to disprove, accounts for the facts of the case.

On the whole, I am inclined to doubt if any *conscious* act of recognition be involved in the return of each guillemot to her own particular egg; for we know that many sea-birds, probably fearing the robberies of the larger gulls, do not willingly leave their eggs unprotected, so that in natural conditions a bird may never actually have to find its egg, but rather its mate whose turn of duty has expired. It seems to me, then, highly probable that, if any conscious act of recognition be involved, it must be dependent upon smell or some other kindred sense.

But surely it is simpler to regard the varied colours of the guillemot's eggs as due purely to a waste product of the bird's metabolism, a product which in some birds, of which the guillemot must be regarded as one, would be forthcoming in abundance at the exciting season of the year, when all the organs of the body are more or less upset by the reproductive processes?

If this view be adopted, diversity of colour follows almost as a matter of course. For it is natural to suppose that in a case like this, where eggs are laid side by side in such large numbers, the question of coloration is unimportant and any colour is admissible which is consistent with the chemical constitution of each particular bird. When I look at a series of eggs of the guillemot I am always reminded of a herd of domestic cattle or a flock of barn-door fowl. In these, when no artificial selection has restricted the colour, the variation is extremely abundant. Like that of the guillemot's egg, however, it has its limits, due to the possibilities of the chemical combinations in the animal concerned. So that while red guillemots' eggs are rare, blue and green cattle are unknown. Further, while in some cases, as in cattle and the eggs of the guillemot, the variation is rich, in others, as in the ass and the eggs of the hedgesparrow, for instance, the range of variation, for reasons at present unknown to us, but probably differing in each instance, is comparatively restricted.

In conclusion, I must add that I am in no sense an opponent of the prevailing theories of protective coloration in birds' eggs as a whole. Such protective colouring almost certainly exists, but I doubt if it be nearly as extensive as is generally supposed, and I would suggest that the coloration is in many cases purely physiological, an aspect of the question which has assuredly been too much nelected.

Orange River Colony. G. E. H. BARRETT-HAMILTON.

Addresses of Authors of Scientific Papers.

MAY I be allowed, through the medium of your columns, to point out the inconvenience that is caused by the omission of an address on authors' separate copies of scientific papers?

Several papers have reached me recently containing valuable and interesting results, but there is nothing to guide me in my search either for the authors' addresses or, in some cases, the name of the periodicals in which their papers were originally published. I am unable, therefore, to acknowledge the receipt of their gift, to send anything in exchange, or to enter into private correspondence with them on their results.

SYDNEY J. HICKSON.

The Owens College, Manchester, October 4.

The Recent Inverness Earthquake.

IN NATURE for September 26 it is stated that the recent Inverness earthquake was not felt in Edinburgh or Glasgow, and apparently the Milne seismograph at the Royal Observatory in the former city gave no indication of any movement. The shock, however, was distinctly felt in Paisley, a few miles west of Glasgow. There are in the Coats Observatory here two seismographs. One of these is a Milne, and it gave no record; but the other, which is Prof. Ewing's, marked the occurrence of the shock. The time as nearly as could be ascertained was 1h. 21m. 35s. The lateral movement was very slight.

ANDREW HENDERSON.

Paisley Philosophical Institution, Paisley, October 14.

THE VIRCHOW CELEBRATION.

A FEW days ago representatives of the world's science met in Berlin to do honour to one of the world's veteran men of science. The occasion of Prof. Virchow's eightieth birthday was seized by many learned societies and private individuals to express their appreciation of the great debt owed by mankind to this epoch-making thinker and worker. The Emperor of Germany bestowed upon him the great gold medal, and the King of Italy a picture in which the Professor's portrait was accompanied by that of his great Italian forerunner, Morgagni. The idea to frame these two scientific men together, whose work, although separated by two centuries of time, illuminated the same branch of knowledge, was certainly a graceful one.

Prof. Virchow was the son of a small farmer in Pomerania, and was born on October 13, 1821. He studied in Berlin, and his first appointment was in connection with the Charité, a hospital which has numbered among its staff many men of European fame. Shortly afterwards Virchow was appointed University Lecturer. About this time he fell somewhat into official disfavour on account, no doubt, of his sympathy with the revolutionary movements of 1848. He left Berlin for the quiet University town of Wurzburg. Here he attracted numerous students and workers, and formed a pathological school which, even after he had quitted it, continued to be one of the best in Europe.

The work by which Virchow will always be known is his "Cellular Pathology." As Lord Lister truly remarked, workers of the present generation cannot conceive the effect which was produced upon the medical world by this book. In 1826 botanists began to regard plants as collections of cells; in fact, Schwann firmly established the position of the cell as the unit of vegetable morphology. Owing, no doubt, to the less distinctly defined characters of the animal cell, it was not until later that Kölliker and others extended the cellular theory to animal tissues. Virchow, in 1858, found a wider application for this theory and demonstrated that pathological tissues also were collections of cells, and that the phenomena of their growth was covered by the generalisation *omnis cellula a cellula*. From that time till to-day Prof. Virchow has been an active worker in pathology, combining the highest critical faculty with an apparently perennial assiduity. In London he is well known; not many years ago (in 1892) he received the Copley medal of the Royal Society, and at that time his great achievements were referred to

[1] See Racovitza, "La vie des Animaux et des Plantes dans l'Antarctique," published by the Société royale belge de Géographie, p. 51, 1900.

at length by the late Sir James Paget in one of his most felicitous speeches. In 1898 he delivered at Charing Cross Hospital the Huxley Lecture, in the English language.

Prof. Virchow has from very early in his career devoted considerable attention to practical hygiene and anthropology. His work upon prehistoric cave-men and Swiss lake dwellings may be taken as a type of the thoroughness with which he accomplished anything he undertook. Last, but not least, the great pathologist was, and indeed is, a politician of no mean order. He entered the Chamber in 1862 and served there till 1878. His work as a politician was devoted to the cause of liberty and truth, and even those who did not agree with his doctrines were unanimous in their respect of his motives.

It is sincerely to be hoped that the aged Professor may for many years to come continue his valuable work, and to all students of science no item of the varied programme of the Virchow celebration was more welcome than the astonishing vigour and youthful earnestness with which the object of their congratulations for two hours, addressed them. F. W. T.

THE RECENT WORK AT STONEHENGE.

At a meeting held last March at Stonehenge and attended by representatives of the Society of Antiquaries, of the Society for the Protection of Ancient Monuments and the Wiltshire Archæological Society, various plans and measures were discussed and suggested for the better preservation of Stonehenge. The whole state of the surrounding neighbourhood being changed from its former quietude by the introduction of new elements, such as the military camps at Bulford, &c., the making of the new branch line of the South-Western Railway (from Grateley to Amesbury), it became necessary to meet the altered circumstances by the exercise of greater precautions for the care of the beautiful old Sun Temple standing in the midst of the grass-clothed downs —a thing of wonder and mystery to behold. The advice given to Sir Edmund Antrobus by the representatives of these societies was as follows, published in the *Times* of April 3.

Resolutions.

(1) That this Committee approves of the suggested protection of Stonehenge by a wire fence not less than 4 ft. high, following on two sides the existing roads and crossing on the west from the 331-foot level on the north road to the 332-foot level on the south road shown on the O.S. map (1–2, 500), Wilts sheet liv. 14.

(2) That the Committee recommends, without prejudice to any legal question, that the local authorities be requested to agree to divert the existing track-way or ridge-way from Netheravon now passing through the earth circle so as to pass from the 302-foot levels in the O.S. map immediately west of Stonehenge.

(3) That stones 6 and 7 with their lintel, and stone 56 (according to the numbering on Mr. Petrie's plan) be first examined, with a view of maintaining them in a position of safety.

(4) That, in the opinion of this Committee, stone 22 should be replaced, stone 21 be made safe, and the lintel of 21 and 22 be replaced in the most safe and conservative manner. The Committee also recommends the re-erection of stones 57 and 58, and their lintel 158.

(5) That the instructions to custodians already in force be approved with a few suggested alterations.

(6) That this Committee feels that it is impossible to overstate the value of the assistance which the County Council of Amesbury can give to the efforts made to preserve this unique monument.

(7) That these resolutions be sent to Sir Edmund Antrobus with the earnest thanks of the Committee, for the part he is proposing to take in the preservation of Stonehenge, also that it be left to him to communicate with the Press.

The fence was erected by Whitsuntide and is 1700 yards in circumference and composed of lightest barbed wire of a neutral tint and absolutely invisible at a distance, so that the traveller gets the whole effect of Stonehenge in its full grandeur instead of, as in former days, the view of the stones mingled with two or three flys, a cart, an old waggonette, and photographer's van, &c., to say nothing of picnic luncheons, spread out within the sacred circle. This fence encloses as large an area as possible,

Fig. 1.—The work at Stonehenge. Raising the leaning stone.

being well outside the vallum except on the west side, where a right of way interferes with the true circle. The next work undertaken—the most difficult and important of the whole—was the raising of the "leaning stone"—the largest monolith in England except Cleopatra's needle—to an upright position. This stone formed one of the uprights of the trilithon the fall of which was said to have been caused by the digging and researches of the Duke of Buckingham in 1620. The horizontal and the other upright (the latter broken in two pieces) now lie prostrate across the altar stone.

The great stone leaned considerably towards the N.E. and appeared to rest upon (actually touching at one point) a beautiful little pillar stone of syenite, the danger being that in some storm, especially after a heavy fall of snow and sudden thaw, the great stone would break in three pieces (having three veins) in falling, and also crush the smaller stone beneath it.

That a forward movement was continually taking place is shown by observations taken by Mr. Flinders Petrie some years ago. It then leaned at an angle of 62, which has been increased to one of 65 degrees lately. The work of the raising of the stone was begun on August 18 and finished September 25, and was under the direct supervision of Dr. Gowland, Mr. Detmar Blow, architect, and his assistant Mr. Stallybrass, and Mr. Carruthers, engineer. The first thing done was to make a fitting to the stone of a strong timber cradle so as to protect it from injury by the immense iron chains and ropes placed round it, these being attached to winches worked by men, so that the stone was actually "wound up," so to speak, into an upright position. Hydraulic jacks were also used. The whole thing was most carefully and slowly done, and devotedly watched over by workers. A rectangular excavation was made in front of the stone, a square excavation at the back. A frame of wood with numbers at equal distances apart was placed over the ground, which was excavated in sections, and the earth was most carefully sifted in layers through four grades of sieves in such a manner that the position of every object found could be recorded. The excavations round the base of the stone are now filled with concrete, and the large struts which uphold it will remain in their positions for six months, until the concrete be thoroughly set.

The objects found were one Roman coin at a shallow depth, and many chippings of both the blue and sarsen stones. Numerous flint axeheads and large stone hammers were also found at a depth of from two feet to three feet six inches underground; all tending to prove the great antiquity of Stonehenge—at least Neolithic. But all this will be discussed scientifically later on.

FLORENCE C. M. ANTROBUS.

BIRD LIFE IN THE CANARIES AND SOUTH AFRICA.[1]

ALTHOUGH the author can scarcely be congratulated on his choice of a title, which in our opinion is too prolix and disconnected, he has succeeded in producing a very readable and interesting little work, based on a stay of six months in the Canaries and a sojourn of about the same duration in South Africa. Much of the contents is devoted to the ordinary incidents of travel, but the special feature of the book is formed by the excellent series of photographs of birds in their native haunts. As every one who has tried bird-photography is aware, but little can be done with the camera in this respect except during the nesting season; but the author's object has been, not to obtain pictures of the birds while actually sitting, but in their natural attitudes when in the neighbourhood of their nesting places. In this way it is possible to show birds in positions which could not be attempted in a drawing; and the value of such pictures for the guidance of the taxidermist who desires to be true to nature cannot be over-estimated. Apart from getting near enough to the bird without disturbing it, there are, however, difficulties connected with this branch of photography which can only be fully realised by those who have had practical experience.

The ideal way of showing a bird, as the author tells us, is perhaps to portray it amid its natural surroundings, but, with rare exceptions, this is unfortunately a practical impossibility in photography. The chief difficulty with which the photographer has to contend is the background—whether this should be in proper focus at the expense of the bird, or *vice versâ*. In most of the photographs the background has been sacrificed; the birds standing out against a dark background, due to out-of-focus distance behind them. This method has the advantage of bringing into relief the various markings and details of the plumage in a manner that would otherwise be impracticable; and, at any rate from the naturalist's point of view, the author is to be congratulated on the success of his method, many of the pictures being perfect representations of bird life.

In the section of the work dealing with the Canaries, a very considerable portion of the text, as well as some of the illustrations, are devoted to the description of the country, its inhabitants and its buildings, so that it is only here and there natural history subjects are discussed at any length. There are, however, several excellent photographs of the nests and eggs of birds—notably the stone-curlew and the Egyptian vulture; and we may call especial attention to the pictures of a malachite sun-bird and its nest (Plate xxii) as first-rate examples of what can be done by photography in portraying the smaller types of bird-life.

In the second part of the volume, which treats of the author's experiences in South Africa, the bird-lover will find a very large amount of interesting matter. Personally, we have been much attracted by the author's account of his visit to Bird Island and St. Croix, two islets lying off Port Elizabeth. Apparently no one is allowed to visit these bird-haunted islets without a special permit, and an amusing story is told of the difficulty of obtaining such permission in this particular instance. Bird Island is the chosen resort of the Cape gannet, and the following account, illustrated by two photographs, gives a good idea of the numbers of these birds in the nesting season:—

"We rounded the north end of Bird Island first," writes Mr. Harris, "and then, close to the lighthouse, and covering quite an acre and a half of ground, were to be seen thousands of Cape gannets. The ground was white with the birds themselves, while above them in the air a kind of kaleidoscopic effect was produced by the ever-moving wings. Among a crowd of birds so thickly packed together as these gannets were, one naturally wonders if it is possible for them to keep to their own eggs; perhaps each bird recognises its own special place from the position of its neighbour. . . . The men at the lighthouse say that these birds arrive in a mass at this, their breeding season, and that when the season is finished the island is untenanted as to bird life until the following year. The spectacle was not so imposing as that presented by the gannets on the Bass Rock in Scotland, where the birds, as seen from a distance, have the appearance of bees swarming round a hive. Here the birds were shown horizontally instead of vertically."

Penguins are likewise abundant on these islands, and the author was fortunate in obtaining two photographs of these birds, in one of which they are shown swimming, and in the other standing on the rocks.

Perhaps the most interesting chapter in the whole book

[1] "Essays and Photographs. Some Birds of the Canary Islands and South Africa." By H. E. Harris. Pp. xvi+212. 8vo. Illustrated. (London: Porter, 1901.)

is the one describing the nesting habits of the two species of sand-plover which frequent the shore on False Bay and in the neighbourhood of Port Elizabeth. The visitor unaccustomed to the ways of these birds always fails at first to discover their eggs, although he may be convinced that they are in his immediate vicinity.

After one or two attempts, says the author, you retire and resolve to watch more carefully. "The bird soon returns to the same spot, shuffles for a second or two very quickly with its feet, and then sits down. This time you make no mistake about the exact place, and you locate the position of the bird with the aid of two little bits of herbage growing near; again you approach, the bird rises as before, and repeats the same performance, standing a little way off, and looking as though it would help you if it could, and if you would only tell it what you were looking for. The ground is quite undisturbed, and there is no sign of a nest or eggs; the little bits of driftwood and bark, though, which lie between your feet are loose, and the earth underneath them is loose also, and then you feel beneath the loose earth and there are two eggs!"

And yet it is difficult to account for this strange habit, since the eggs so closely resemble their surroundings that they would be passed unnoticed when lying on the bare ground. Often the nesting-site is in a locality much frequented both by men and cattle, and it is a marvel that all the eggs are not broken. On one occasion the author actually found an ox lying down on a nest whose situation was known to him; strange to say, although one egg was crushed, the other was intact. The proceedings of the parent bird while thus effectually prevented from obtaining access to her nest are described with some humour by the author.

Many other anecdotes might be culled from Mr. Harris's pages, but enough has been said to indicate the interesting character of his work and the large amount of information with regard to the habits of birds that it contains. The author has been fortunate in obtaining the assistance of Mr. Howard Saunders in revising the nomenclature, so that ornithologists may be satisfied that the various birds alluded to are correctly identified.

R. L.

Cape Gannets on Bird Island.

THE REPORT OF THE THOMPSON YATES LABORATORIES.

THE Thompson Yates Laboratories Report, lately published, edited by Profs. Rubert Boyce and C. S. Sherrington, is a worthy successor to the preceding volumes, which have previously been reviewed in these columns. The distribution of *B. coli commune* is the title of the first paper, by Miss Chick, who concludes that this organism is not so generally distributed as has been considered by some bacteriologists, and that its presence may be looked upon as useful evidence of recent fæcal contamination. Her experiments show the very low resistance which the *B. coli* can offer to unfavourable conditions, especially desiccation.

Mr. E. E. Glynn has investigated the relation between the *Bacillus enteritidis sporogenes* of Klein and diarrhœa. He has isolated this micro-organism from normal dejecta, dust, air, milk, and sugar, and has tested the effects of cultures upon guinea-pigs and upon himself by ingestion without evil result. He agrees with Dr. Hewlett that the *Bacillus enteritidis sporogenes* is a ubiquitous organism, and that there is at present no satisfactory evidence that it is a cause of diarrhœa.

Mr. A. T. MacConkey gives further details of his bile-salt lactose Agar medium for the isolation of *B. coli* and *B. typhosus*, for which purpose it seems to be a valuable addition to the methods hitherto in use. Mr. MacConkey also publishes a note on flagella staining, Mr. K. W. Monsarrat describes a primary malignant growth of the kidney, and Dr. Christophers discusses the prevention of malaria in Tropical Africa.

Enlargement of the spleen has been relied upon by many as the test of the prevalence of malaria in a district; but Dr. Daniels concludes that the spleen-test may be worse than useless unless race and age are taken into account.

FIG. 1.—Anopheles larvæ in several stages of their escape from the ova.

Two well-executed full-page diagrams by Messrs. Ross and Fielding-Ould illustrate the life-history of the parasites of malaria, while the last half of the volume is occupied with the Report of the Malaria Expedition to Nigeria of the Liverpool School of Tropical Medicine. The latter contains many good illustrations of the characteristics of the country and of the development of Anopheles. Two of these are here reproduced, one (Fig. 1) showing Anopheles as ovum and larva, the other (Fig. 2) a breeding-ground of Anopheles.

FIG. 2.—Portion of a cultivated area at Lokoja, showing butts and furrows, in the latter of which Anopheles puddles occur.

A portrait and short obituary notice of the late Dr. Myers and an illustration of the Kanthack Medal in Pathology also appear in this volume. All the papers are valuable contributions to the science of medicine, and we shall look forward with interest to the publication of future volumes.

R. T. H.

NOTES.

THE Cape papers, says the *Times*, report the formation at Cape Town of a "South African Association for the Advancement of Science," to work as far as possible on the lines of the British Association. In July last a meeting was held to establish a congress of engineers, when an influential committee was appointed. The proposal gradually widened until at length it was found feasible to establish a local "British Association," and a meeting for that purpose, held under the chairmanship of Sir David Gill, F.R.S., the Astronomer Royal at the Cape Observatory, was largely attended, and the formation of the Association having been decided upon by formal vote, the title was discussed, "South African" being carried by 31 votes against 19 for "African."

A REUTER telegram of October 14 from Cape Town states that the *Discovery* sailed that day from Simon's Bay for Lyttelton, New Zealand.

THE resignation of Dr. John Young, professor of natural history and lecturer in geology in the University of Glasgow, is announced. Dr. Young, who was appointed in 1866 to the professorship he now vacates, will retain his connection with the Hunterian Museum, of which he has for a number of years been curator.

PROF. JOHN JOLY, F.R.S., has, subject to the approval of the Lord Lieutenant, been co-opted to fill the vacancy on the Irish Lights Board caused by the death of Mr. J. Pim.

MR. J. R. JACKSON, who for a period of forty-three years has been associated with the Royal Gardens, Kew, has resigned the keepership of the Museum of Economic Botany, and is succeeded by Mr. J. M. Hillier, whose place, in turn, has been taken by Mr. J. H. Holland, late of the botanic station at Old Calabar.

THE death is announced in the Allahabad *Pioneer Mail* of Dr. Vonkrafft, of the Geological Survey of India, who was appointed to India by the Secretary of State and has, since January, 1899, been mainly employed in the Himalayas.

THE fiftieth scientific anniversary of M. Berthelot (he began his career as a chemist in 1851) is to be commemorated, says the *Chemist and Druggist*, by the presentation to him next month of a metal plaquette by his colleagues of the Institute of France. On the front of the plate, which is the work of Chaplin, the engraver, the recipient's portrait will be reproduced in profile, and on the back M. Berthelot will be portrayed seated at his laboratory table, "Truth" illuminating him with a torch, and "Patrie" protecting him under a flag and offering him a crown of laurels.

THE first Egyptian Medical Congress will be held in Cairo, under the presidency of Dr. Ibrahim Pacha Hassan, from December 10 to 14 next.

AN Industrial and Art Exhibition will be held at Düsseldorf next year, and already the intending exhibitors number about 2300. The exhibition will embrace the following groups:—mines and saltworks; smelting works; the metal industry; machinery and electrical engineering; transport; chemical industry; articles of food, &c., and apparatus for preparing them; stone, earthenware, porcelain, cement and glassware; the wood and furniture industries, house decoration, &c.; fancy goods and small wares; the textile industry; clothing trades; leather, indiarubber and asbestos goods; the paper trade; the printing trade; scientific instruments; building and engineering; education; hygiene and benevolent institutions; sport; horticulture; agriculture and forestry; and art. As was the case with the Paris Exhibition of 1900, a large number of international and other congresses will be held at Düsseldorf during the exhibition.

THE general committee of the Photographic Salon will hold an "At Home" at the Dudley Gallery, Egyptian Hall, on Tuesday next, at 8.30 p.m.

THE next meeting of the Institution of Mechanical Engineers will be held to-morrow, the 18th inst., when Prof. Burstall will present the second report to the Gas-Engine Research Committee. At the November meeting of the Institution a paper will be read by Prof. Dalby on the balancing of locomotives.

A REUTER telegram from St. Petersburg states that a letter has been published in the *Turkestanskiya Viedomosti* giving the following information concerning Dr. Sven Hedin, the Swedish traveller, based upon a letter from him, dated July 10. It appears that Dr. Sven Hedin, at the time of the despatch of the letter, was at the foot of the Akka Tagh, in Northern Tibet, and intended to proceed in the direction of Ladak in order to survey accurately the region about the source of the Indus. Next spring he proposes to return to Osh *via* Kashgar. Meanwhile, a caravan of fifteen horses has arrived at Kashgar bringing the results of two years of the traveller's work in the shape of scientific collections, maps, photographs and diaries. Dr. Sven Hedin speaks in the highest terms of his Cossack escort and extols their courage, endurance and resource in critical situations. Up to the time of writing he had been in no way molested by the Chinese.

THE Liverpool School of Tropical Medicine, according to a Reuter telegram, has now completed the necessary arrangements for the despatch of an expedition at once to the Gold Coast, and to the mining districts there. Dr. Charles Balfour Stewart, under whose leadership the expedition will be, leaves for West Africa this month. He first proceeds to Sierra Leone in order to study the methods now being employed there with such success by Dr. Logan Taylor. After leaving Freetown, Dr. Stewart will go at once to Cape Coast Castle to attack the insanitary conditions there, as the mortality amongst the Europeans in that town is at present most serious. He is to adopt, under Major Ross's general direction, the latest methods known to science for obtaining the end in view, and will employ large gangs of workmen for draining the ground and clearing the houses of broken water vessels and otherwise attacking the breeding-grounds of the mosquitoes. As regards the movements of the expedition, these, to a great extent, will be determined by the Governor, Major Nathan, with whom Major Ross had a personal interview on the Gold Coast two months ago, when the Governor promised the expedition most valuable assistance. The expedition has been rendered possible owing to the generosity of a private individual who desires to remain anonymous. Anti-malarial operations will shortly be in full swing in the Gambia, Sierra Leone, the Gold Coast, and Lagos, the operations in the three first named colonies being organised by and under the complete control of the Liverpool School of Tropical Medicine.

IT has been decided that the house which Prof. O. C. Marsh bequeathed to Yale University shall in future be known officially as Marsh Hall, and the grounds in connection with it as the Yale Botanical Garden.

THE subject of the Fiske Fund Prize Essay (value 200 dollars) for the year 1902 is, says *Science*, "Serumtherapy in the Light of the most recent Investigations." The secretary of the board of trustees of the Fund, from whom all necessary information may be obtained, is Dr. H. De Wolf, 212, Benefit-street, Providence, R.I., U.S.A.

THE following awards have been made by the Institution of Civil Engineers for papers dealt with in 1900–1901:—A Telford Medal and Premium to R. P. Bolton; a Watt Medal and a Telford Premium to J. E. Dowson; a George Stephenson Medal and a Telford Premium to W. T. C. Beckett; a Manby Premium to E. K. Scott; a Trevithick Premium to T. A. Hearson; a Telford Premium to J. A. W. Peacock. For students' papers the awards are:—A Miller Scholarship (tenable for three years) and the James Forrest Medal to E. V. Clark; Miller Prizes to C. E. Inglis, H. E. Wimperis, J. L. Cridlan, F. K. Peach, G. H. Whigham, F. Taylor, A. C. Walsh and H. O. Jones.

A NUMBER of awards are to be made by the Industrial Society of Mülhausen, in 1902, among which the following may be noted:—A medal of honour and 400–800 marks, according to the value, for a handbook consisting of tables giving the density of the greatest possible number of mineral and organic combinations in crystal form and in saturated cold solutions. The solution-capacity at other temperatures is to be added to the work as a supplement. A silver medal for the synthesis of a product possessing the most important qualities of Senegal gum capable of use in textile industries. A medal of honour and 800 marks for a substance which may be used as a cheaper, substitute for dry egg-albumen in the printing of fabrics. A medal of honour and 800 marks for a colourless blood-albumen which will not become coloured when steamed. A silver medal for a handbook treating of the analysis of the drugs used in calico-printing and in dyeing. A silver medal for an ink which can be used for marking woollen fabrics to be dyed red, brown, or any other dark colour. This ink must remain visible after all the dyeing processes. A silver medal for a practical process of removing spots of mineral-fat from fabrics. A silver medal for a treatise on the preparation of hydrogen peroxide, and its application for bleaching textile fabrics. For these prizes foreigners are allowed to compete. All drawings, samples, &c. should be marked with a motto and sent before February 15, 1902, accompanied by a sealed envelope containing the name and address of the competitor, to the Präsidenten der Industriellen Gesellschaft, Mülhausen, Alsace.

PRIZES are offered by the English Arboricultural Society for the best essays on the following subjects:—The more extensive cultivation of hardy flowering shrubs; the arboricultural management of private and public parks; an essay on any insect or group of insects injurious to forest trees; the natural regeneration of oak and beech woods; on the management of young trees, with the view of rendering them suitable for planting in avenues, streets and other places; the relative durability of British-grown exotic trees; on the growth and freedom from disease in this country of larches, other than the common European larch; the financial aspect of forestry, with special reference to actual cases. In addition to the foregoing, Mr. H. J. Elwes, F.R.S., offers a special prize for a paper on natural reproduction of trees by seed in England. The next annual meeting of the Society will be held in France.

THE following gentlemen have been nominated to serve on the council of the London Mathematical Society for the ensuing session:—President, Dr. Hobson; vice-presidents, Prof. W. Burnside and Major MacMahon, R.A.; treasurer, Dr. J. Larmor; hon. secs., R. Tucker and Prof. Love; other members, J. E. Campbell, Lieut.-Colonel Cunningham, R.E., Prof. Elliott, Dr. Glaisher, Prof. M. J. M. Hill, H. M. Macdonald, Prof. L. J. Rogers*, A. E. Western, E. T. Whittaker and A. Young*. Those marked * are new nominations. The retiring members are Lord Kelvin and Mr. A. B. Kempe. The annual meeting will be held at 22, Albemarle-street, W., on November 14, at 5.30 o'clock.

EXPERIMENTS have recently been made in the State of Connecticut for the purpose of cultivating the Sumatra tobacco plant. It is stated that the experiments have been very successful, and great interest is now being taken in the matter in order to improve the quality of the Connecticut leaf, which is much used as a wrapper for the better quality cigars.

MAJOR RONALD ROSS informs the *British Medical Journal* that he has recently received a communication from a Jamaica correspondent drawing his attention to the fact that mosquitoes are responsive to certain sounds, such as a continuous whoop or hum. Major Ross's informant states that swarms gather round his head when he makes a continuous whoop. There may be, however, he says, some particular note or pitch that would be more attractive to them.

AT the recent meeting of the American Association, in the Section of Chemistry, Prof. J. H. Long, president of the section, delivered an interesting address on the teaching of chemistry in the medical schools of the United States. The first part of the address was devoted to sketching historically the teaching of chemistry in the American medical schools. A prominent individuality in this connection was Dr. Robert Hare, whose great merit apparently consisted in the ingenuity he displayed in contriving experiments to illustrate simple chemical principles to medical students. While Hare was prominent in Philadelphia, Silliman, Gorham and Mitchell were developing the departments of medical chemistry in Yale, Harvard and Columbia. The next step in the teaching of chemistry to medical students was the institution of laboratory courses; this did not take place at Harvard until 1872. Subsequently to this an important question arose as to the qualification of the teacher of so-called medical chemistry. Since, formerly, the main use of chemistry to the medical student lay in its direct application to pharmacy it was held that this subject was best taught by a physician; the growth, however, of physiological chemistry, and the obvious relation of chemical principles to physiology and pathology, rendered it of the first importance that medical students should be well grounded, not only in the properties of isolated substances as heretofore, but in the actual principles of organic and inorganic chemistry. A trained chemist alone was competent to teach upon these lines, and hence the medical chemistry taught by the physician became replaced by chemistry taught by a chemist. The remainder of Prof. Long's address dealt with the far-reaching importance of chemistry, inorganic as well as organic, to the medical student, and the inadequacy of mere analytical courses, into which there is apparently some danger of the teaching of chemistry degenerating. He emphasises the fact, well recognised in this country, that the burning problems of the physiology, the pathology and therapeutics, if not of to-day, certainly of the near future, are essentially chemical, and instancing the work of Bredig upon the fermentative action of colloidal platinum, &c., points out that they are by no means necessarily confined within the accepted limits of so-called organic chemistry.

THE Imperial Department of Agriculture for the West Indies maintains its activity in supplying the colonists with the most trustworthy information bearing upon the various subsidiary industries which should, with a little energy and patience, bring about a great improvement in the welfare of the islands. Pamphlet Series, No. 9, now being distributed, deals with "Bee-Keeping in the West Indies." In Europe and America there is a large and ever-increasing demand for honey and beeswax, yet the West Indian islands, with their dozens of varieties of honey-bearing flowers all round the year, may be said, with the exception of Jamaica, to have thus far made no real attempt to regard bee-keeping as worthy of encouragement. Mr. W. K. Morrison, formerly of the United States Department of Agriculture, has been engaged by Dr. Morris as expert adviser to the Imperial Department, and he has been touring amongst the islands during the first half of the present year studying the conditions and prospects of bee-keeping. The outcome of his investigation is this pamphlet of 73 pages, conveying to all who wish to increase their income in an easy manner simple hints and suggestions as to the requirements of tropical bee-keepers. Only a small capital is required to make a good start, and the profits are large so long as a sound and attractive article is produced. It is indicative of the natural carelessness of the colonists that it should be considered necessary to dwell upon this weakness, for in insisting that a high standard of excellence is required to secure remunerative prices on the European markets, it is added that "The great danger to West Indian bee-keeping will probably lie in the tendency to ship abroad honey or wax of an inferior quality." The pamphlet, which is illustrated, is a veritable storehouse of instruction, and should be the means of originating an industry which may add considerably to the wealth of the islands.

PROF. T. LEVI CIVITA, writing in the *Atti dei Lincei*, discusses the law of fluid resistance, and in particular the property that this resistance varies approximately as the square of the velocity, as a consequence of the properties of discontinuous motion in a perfect fluid. The author obtains for the most general case an expression for the resistance in the form of a series of even powers of the velocity, which series is convergent for velocities below a certain limit, and in the cases commonly occurring in practice reduces approximately to its first term, giving Newton's law.

IN a recent *Bulletin* of the Agricultural College at Tokyo there is an investigation by Mr. Aso on the causes of the difference in colour between green and black tea. In making green tea the leaves are steamed as soon as gathered; in the case of black tea the leaves are allowed to ferment before drying. The finished black tea contains much less tannin than the green. The author shows that the original tea-leaf contains an oxidising enzyme, which is destroyed by heating to about 77° C. During the fermentation of the leaf in the manufacture of black tea this enzyme oxidises the tannin, giving rise to a brown product.

THE June issue of the *Monthly Weather Review* of the U.S. Weather Bureau has a note stating that an observer at Tillers Ferry, South Carolina, had reported that during a heavy local rain in June there fell hundreds of small fish (cat, perch, trout, &c.), which were afterwards found swimming in the pools between the cotton rows in a field. "It is," says the *Review*, "a well-known fact that in such rains all sorts of foreign objects, whether sticks or stones, frogs or fish, or even débris of destroyed houses and crops, occur occasionally, not only in America, but in Europe and elsewhere. It is very rare that we are able to trace these objects back to their sources, but there can be no reasonable doubt that they were carried up from the ground by violent winds, such as attend thunderstorms and tornadoes."

INTERNATIONAL balloon ascents (both manned and unmanned) were undertaken by several countries on July 4 and August 1. The greatest heights at which records were obtained in July were at Trappes, near Paris, 10,270 metres, temperature −52° C. (on ground 16°·5), and at Chalais Meudon, 10,260 metres, temperature −43° (on ground 16°·7). In August, the greatest heights at which observations were recorded were:—Trappes, 9800 m., temperature −40° (on ground 17°·5); Berlin (July 31), 13,040 m., temperature −48° (on ground 15°·1). Drs. Berson and Suring reached an altitude of 10,300 m., temperature −40°. At Vienna a temperature of −33° was recorded n an unmanned balloon at a height of 10,000 metres.

AN agreement has just been concluded between Marconi's International Marine Communication Co., Ltd., and Lloyd's, by which the latter agree to employ no system of wireless telegraphy other than the "Marconi" for a period of fourteen years. The agreement also provides for the immediate equipment of ten Lloyd's signalling stations, one of which is to be on the Fastnet Rock and two on the Red Sea coast, together with the taking over of some of the existing British stations, of which there are at present eight, that could be rendered serviceable to Lloyd's for mercantile signalling.

THE *Monist* for October contains the translation of a paper by Prof. Ludwig Boltzmann on the necessity of atomic theories in physics. In it the author compares the atomic theory with the second method, which seeks to represent the facts of physics by means of differential equations; the latter method he calls "mathematico-physical phenomenology." The object of the paper is to discuss the advantages arising from the retention of the atomic theory, and its claims to be studied at least in parallel with the phenomenologic method. Even if it should be possible to formulate an all-embracing theory of the world, every feature of which has the same evidence as Fourier's theory of the conduction of heat, Prof. Boltzmann thinks it is still an open question whether such a theory can be more easily reached through atomism or phenomenology. It would even be permissible to assume that several representations of the universe, each possessing the ideal traits, were possible.

A SINGLE bone of the wing, and that imperfect, may nowadays seem but poor material on which to establish a new genus of birds, but Dr. F. A. Lucas (*Proc. U.S. Mus.*, vol. xxiv. No. 1245) appears to be justified in regarding a humerus from the Miocene of Los Angeles, California, as representing a large extinct type of flightless auk. For this the name *Mancalla californiensis* is suggested; it is considered to have equalled the great auk in size, but to have been more nearly allied to the guillemot. The existence of a flightless member of the group at such a comparatively early epoch is considered remarkable. In the same journal Messrs. Jordan aud Snyder continue their review of the fishes of Japan, dealing in No. 1241 with the hypostomid and lophobranchiate types, and in No. 1244 with the gobies, of which no less than twenty-one species are described as new. No. 1242 of the journal in question contains Mr. R. V. Chamberlin's account of myriopods of the Lithobius group, while No. 1243 is devoted to the description of new flies from Southern Africa, by Mr. D. M. Coquillett.

THE development of the typical flies (Muscidæ) forms the subject of an elaborate investigation by Herr W. Noack, the results of which are published in the latest issue of the *Zeitschrift f. Wissenschaft. Zoologie* (vol. lxx. part i.). No less than eight distinct stages in developmental history are recognised. In another article in the same issue Herr J. Schaffer, of Vienna, commences a dissertation on the histology and development of cartilaginous structure, and the various modifications assumed by that substance.

SOME time ago Dr. D. G. Elliot's "Synopsis of North American Mammals" (*Field Museum Publications*) was noticed in our columns. The author has supplemented this with a "list" of the mammals of the same area (*Field Mus.—Zool.* vol. ii. No. 2), which contains a few names omitted from the larger work, together with some published too late for inclusion in the latter, and such emendations as have been found necessary. In the same journal (vol. iii. No. 5) Dr. Elliot describes and figures the reindeer, or caribou, of the Kenai Peninsula, Alaska—the *Rangifer stonei* of Dr. J. Allen—in the course of which he throws doubts on the distinctness of this form, and suggests that the American reindeer have been too much subdivided by recent writers.

IN accordance with a recent decision of the council, the first part has been issued of "Obituary Notices of Fellows of the Royal Society." It contains the biographies of recently deceased Fellows, reprinted from the year books for 1900 and 1901, together with an index to the obituary notices previously published in the Society's *Proceedings*.

IN their new catalogue, Messrs. C. Baker, of High Holborn, announce that they have arranged a series of free demonstrations during the coming session, illustrating the use of apparatus for the illumination of microscopic objects, testing of objectives, micrometry and drawing with the microscope. Another announcement of some interest refers to the microscopic slide-lending department, which has now been placed in the hands of various specialists, who have prepared type-written descriptions of most of the series of objects sent out; these should considerably increase the educational value of the system. Of other items we may cite a new engineering microscope (for examining metals) and a mosquito-collecting outfit (for malarial observations), as illustrating the large variety of apparatus now supplied to meet the requirements of modern specialisation.

HANN'S "Lehrbuch der Meteorologie" (Tauchnitz) is now complete. It consists of 10 Lieferungen instead of 8, as was originally proposed.

A PRACTICAL journal for amateur gardeners has just made its appearance under the title of *Garden Life*. The journal informs horticulturists what to do and how to do it, but it mostly leaves the reasons for the operations out of consideration. We suggest that there is a science as well as an art of horticulture, and that descriptions of simple experiments in the physiology of plants, or studies of plant diseases, might be included in the contents of future numbers.

SOME specimen copies of the *Boletim mensal* of the Observatory of Rio de Janeiro have been forwarded to us by the director. These bulletins contain useful meteorological *résumés* collected from various sources in Brazil for a series of years, and tables of the observations made several times daily at the Observatory. There are also occasional climatological sketches referring to other parts of the world.

THE September issue of *The Scientific Roll* (Bacteria) has reached us, and contains a mass of references to books and papers dealing with bacteriology. An editorial note states that although the list is fuller than any other published, it still has many omissions, and bacteriologists who find in it no mention of their contributions are reminded that the remedy is in their own hands, and are invited to send to the conductor the titles and other particulars of the books and articles they have published, that the same may be noted.

THAT well-produced periodical the *Reliquary and Illustrated Archaeologist* always contains some articles of scientific interest, and the issue for October is no exception to the rule. Mr. John Ward, of the Cardiff Museum, describes the interesting "Five Wells Tumulus" in Derbyshire, and another article of note is that by Mr. W. J. Wintemberg, dealing with "Drills and Drilling Methods of the Canadian Indians." Both papers are suitably illustrated.

THE additions to the Zoological Society's Gardens during the past week include a Tantalus Monkey (*Cercopithecus tantalus*) from Africa, presented by Sergeant T. Golding; a White-throated Capuchin (*Cebus hypoleucus*) from Central America, presented by Mr. C. E. Engelbach; a Kinkajou (*Cercoleptes caudivolvulus*) from South America, presented by Mr. W. B. Hall; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mrs. Lester; two Indian Crows (*Corvus splendens*) from India, presented by Mr. Boyek; a Macaque Monkey (*Macacus cynomolgus*) from India, a Parry's Kangaroo (*Macropus parryi*, ♀), four Musky Lorikeets (*Glossopsittacus concinnus*), a Turquoisine Parrakeet (*Neophema pulchella*) from Australia, deposited; a Gouldian Grass Finch (*Poëphila gouldiae*), a Beautiful Grass Finch (*Poëphila mirabilis*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

THE SPECTROSCOPIC BINARY η PEGASI.—Observations of this interesting spectroscopic binary, discovered by means of the Mills spectrograph in August, 1898, have now extended over more than two complete periods, and Prof. Campbell has recently issued the data obtained from the reduction of the measures. Twenty-nine photographs, extending from 1896 August 27 to 1901 May 9, have been utilised in the determination of the orbit.

Elements of Orbit, η Pegasi.

$$
\begin{aligned}
K &= 14{\cdot}20 \text{ km.} \pm 0{\cdot}13 \text{ km.}\\
e &= 0{\cdot}1548 \pm 0{\cdot}0106.\\
\omega &= 5^\circ{\cdot}605 \pm 3^\circ{\cdot}708.\\
\mu &= 0{\cdot}007681 \text{ rad.} \pm 0{\cdot}000020 \text{ rad.}\\
&= 0^\circ{\cdot}44009 \pm 0^\circ{\cdot}00117.\\
T &= 1898 \text{ June } 29{\cdot}7 \pm 8{\cdot}1 \text{ days.}\\
&= 1901 \text{ September } 25{\cdot}7.\\
V_0 &= +4{\cdot}31 \text{ km.} \pm 0{\cdot}10 \text{ km.}\\
U &= 818{\cdot}0 \text{ days} \pm 2{\cdot}2 \text{ days.}\\
a \sin i &= 157{,}800{,}000.
\end{aligned}
$$

A light curve embodying the above is given, from which it is found that the maximum velocity is $+20{\cdot}70$ km. per second, and the minimum $-7{\cdot}70$ km. per second.

The star has been carefully examined with the 36-inch refractor, but no indication of the companion star is to be seen (*Lick Observatory Bulletin*, No. 5).

THE HAMBURG MEETING OF THE GERMAN ASSOCIATION.

THE seventy-third meeting of the German Association of Naturalists and Medical Men lately held at Hamburg was an unusually successful gathering. It will be remembered that it was the existence of this institution which suggested the foundation of our British Association, the latter being only a few years junior to the former. Though otherwise alike, the two associations nevertheless differ in some important respects, especially in the fact that the German body still unites with its purely scientific work functions performed here by the British Medical Association. Another notable difference lies in the fact that presidential addresses, which form so important a feature with us, are not delivered at the German congress. There are, moreover, no popular lectures of any kind, and it is understood that no one shall attend sectional meetings who is not professionally interested in the matters discussed. A good attendance of men of science is further promoted by the fact that it is the custom of some of the learned societies of Germany to hold their annual meetings in connection with this congress.

The meeting just concluded was formally opened on Monday, September 22, in the great Concerthaus, under the presidency of Prof. Richard Hertwig (Munich). On behalf of the municipality of Hamburg, speeches of welcome were delivered by Prof. Voller, Dr. Hartmann and Prof. von Neumayer, to which the president responded. After these proceedings Prof. Lecher (Prag) delivered an address on the discoveries of Hertz and their subsequent developments, reminding the audience that Hertz was a Hamburg man and that his work was most appropriately taken for the first consideration of the congress. A lecture from Prof. Hoffmeister was to have followed, but illness prevented him from attending. Prof. Boveri (Würzburg) then lectured on the problem of fertilisation, giving a lucid account of the phenomena in a considerable number of organisms, and concluding with an emphatic pronouncement that fertilisation in its essence must not be regarded as the cause of the development of the ovum, but rather as a means whereby certain organisms are enabled to combine in one body the characters of distinct individuals.

The congress then broke up into sections, of which eleven were devoted to the natural sciences and sixteen to medical subjects, physiology being included with the latter. Prof. van 't Hoff acted as president of the scientific, and Prof. Naunyn as president of the medical groups respectively. The division of the scientific subjects differs somewhat from that followed with us, the sections being constituted thus:—Mathematics, Physics, Applied Mathematics, Chemistry, Applied Chemistry, Physical Geography, Geography, Geology with Mineralogy, Botany, Zoology, Anthropology. For the consideration of these sections some hundreds of papers were provided.

On Wednesday the congress met in a second general session to hear a group of papers on recent developments of the atomic theory, namely, Prof. Kaufmann (Göttingen), on the development of the conception of electrons; Prof. Geitel (Wolfenbüttel) on the bearing of the theory of gas-ions on the phenomena of atmospheric electricity; Prof. Paul (Tübingen), the significance of the theory of ions in physiological chemistry; Prof. His, jun. (Leipzig), the significance of the theory of ions in clinical medicine. On the following day the medical group combined in a general meeting to receive an address from Prof. Ehrlich, of Frankfurt-a-M., on the protective substances of the blood. Prof. Gruber (Vienna), who was to have lectured on the same subject, was unavoidably absent. On the same morning a joint meeting of the scientific group assembled with Prof. van 't Hoff in the chair. The first paper was by Prof. Ostwald (Leipzig) on catalysis, giving an account of his hypothesis, or as he preferred to call it "protothesis," regarding the mode of action of catalysers, accompanied by some beautiful demonstrations. This was followed by a group of papers relating to the present position of the doctrine of organic descent. Prof. de Vries, of Amsterdam, opened with a discourse on the action of mutations and mutation-periods in the origin of species. He gave an account of his lately published experiments with *Œnothera Lamarckiana*, showing how this single species is annually splitting up into some seven constant forms which he regards as distinct species. He proceeded to suggest lines on which an attempt might be made to compute the whole number of mutations which have gone to the formation of an existing species. He was followed by Prof. Koken (Tübingen), on palæontology and the theory of descent, and Prof. Ziegler (Jena), on the present position of this theory in zoology.

On Friday another general meeting of the whole congress was addressed by Prof. Curschmann (Leipzig), on medical science in connection with the shipping industry; by Prof. Nernst (Göttingen), on the use of electrical theories and methods in chemistry; and by Prof. Reinke (Kiel), on the natural forces at work in organisms.

Several important joint meetings of two or more sections also took place, notably of the biological sections, to discuss the position of biological teaching in schools, the subject being opened by Dr. Ahlborn, of Hamburg. In this discussion Profs. Reinke, Waldeyer, Heincke, R. Hertwig, Chun and others took part, and a committee was formed to consider the matter further. The same sections also were addressed by Prof. R. Hertwig, on the cell theory, Prof. Reinke, on cells without nuclei, and by Prof. Correns, of Tübingen, on recent discoveries in hybridisation and their bearing on theories of heredity. In connection with the latter paper the author exhibited a remarkable series of specimens illustrating the Mendelian laws of heredity. Joint meetings of the physical and chemical sections also took place to hear papers by Profs. Schilling (Göttingen), Charlier (Lund), Halm (Edinburgh), Simon (Frankfurt), Geitel (Wolfenbüttel), Abegg (Breslau), Hantsch (Würzburg), Wegscheider (Vienna), and many others. The medical and physiological sections had a no less extensive programme, a special feature being a joint meeting in the Concerthaus to receive an address by Prof. Kronecker (Berne) on the innervation of the mammalian heart.

Other meetings of considerable importance were those of the Tuberculosis Committee, under the chairmanship of Prof. Hueppe (Prag). Among the long series of papers read may be mentioned a communication by Dr. Grünbaum, of Liverpool, made on behalf of Prof. Boyce and himself, to the effect that positive evidence had been obtained by them that bovine tuberculosis could be communicated to the chimpanzee.

Besides the meetings and demonstrations some interesting exhibitions had been organised, amongst others displays of chemical, physical and surgical apparatus, a series of demonstrations of Röntgen-ray apparatus, of the methods of colour-photography, &c. The museums and other scientific and medical institutions of Hamburg were open throughout the week to members of the congress. As of special interest to naturalists may be named the novel preparations of Dr. Michaelsen, showing by means of artificial spirit-aquariums the modes of life of molluscs, worms and other marine organisms. In the Zoological Garden were exhibited the skeleton and stuffed skin of the gigantic gorilla lately brought from the Cameroons, and bought for the Tring Museum. This specimen, which stands some 6 feet high, is believed to be the finest in Europe. On Friday a special visit was made to the new institution for preventing the introduction of agricultural pests. This is the only institute of the kind in the world excepting that in New York. In it an attempt is made to disinfect all fruit and vegetable produce coming to the port of Hamburg, and thus to check the spread of exotic pests.

Each member was presented with a guide-book and with a large quarto treatise of 600 pp. describing and illustrating the natural history of the district, its scientific institutions and resources, similar treatises on the medical and hygienic institutions being in addition presented to the medical members. Each member also received a silver medallion-badge of great artistic distinction specially designed by Herr Illies.

The festivities organised and for the most part provided by the municipality and by residents in Hamburg were on an unusually magnificent scale, far exceeding anything of the kind that had been done before, and probably these evidences of the wonderful prosperity of the great free town will be to the foreign visitor among the most lasting memories of the meeting.

On Sunday, before the congress officially began, the members were invited to see a procession of boats dressed in flowers, which rowed round the inland waters of the Ausser Alster, the entertainment concluding with fireworks on the lake. On Monday the Zoological Garden was illuminated. On Tuesday some 1300 members of the congress were received by the Burgomaster and Senate of Hamburg and entertained at supper in the princely suites of rooms composing the new Rathhaus, while the remainder were invited by the directors of the Hamburg-America line to a similar entertainment on board two of the company's largest vessels. A "Festessen" took place in the Zoological Garden on the following day, at which some 1500 dined simultaneously. On Thursday a concert was provided, followed by a ball, and on Friday the whole congress was conveyed down the river in five large steamers to Blankenese, returning after dark to see the illuminations which had been arrayed along the whole length of the Elbe. Later in the evening those who were not quite exhausted returned to the Concerthaus to take part in further proceedings of a hilarious character and to listen to speeches of farewell.

On the following day the congress broke up, some joining an excursion to Heligoland, while a larger number went on a two days' expedition to Kiel, Lübeck and other places of interest.

The organisation was brought to the highest possible point of efficiency, and most of the office work throughout the meeting was patiently supplied by volunteers. Provision for the comfort of visitors went even so far as to fill the incoming trains with maps of the town and printed information on all practical matters, and students were waiting on the platforms to find lodgings for and to direct those who might need such help. The number of those who became members for the meeting is said to have exceeded 3000, about 1000 being lady-associates. For the latter, separate entertainments of various kinds were organised on a lavish scale, to take place each day during the scientific business.

It was announced that the meeting for next year will be held at Karlsbad under the presidency of Prof. Chiari, of Prag, with Prof. Selenka and Prof. Stintzing as presidents of the scientific and medical groups, respectively.

PRIZES FOR RESEARCHES IN MEDICAL SCIENCE.

THE issue of the *British Medical Journal* for August 31 is the annual educational number, in which particulars are given as to the medical curriculum, the ways to degrees or other qualifications, and the various medical schools. This number and that of September 7 contain a few particulars as to open scholarships and prizes which are awarded for the purpose of assisting investigations in various subjects connected with medicine, or for researches actually accomplished. The assistance to scientific work given by the Royal Society and the British Medical Association is too well known to make any description of it necessary, but the following statement, abridged from our contemporary, contains mention of many prizes for research not generally known to exist, some of which confer distinction far beyond their monetary value.

The Weber-Parkes Prize is awarded by the Royal College of Physicians every third year for an essay on some subject connected with the etiology, prevention, pathology, or treatment of tuberculosis, especially with reference to pulmonary consumption in man. The prize consists of 150 guineas and a silver medal. A similar medal is also awarded to the essayist who comes next in order of merit. There was no award made in 1900.

The Jacksonian Prize of the Royal College of Surgeons is open to Fellows or members of the College. Its annual value is about 12*l*. For 1901 the subject for the prize is the diagnosis and treatment of bullet wounds of the chest.

The Astley Cooper Prize is a triennial prize of the value of 300*l*., which will be next awarded in 1904 for the best essay on the pathology of carcinoma and the distribution and frequency of occurrence of the secondary deposits, corresponding to the various primary growths. The essays must contain an account of original experiments and observations not already published, and be illustrated as far as possible by preparations and drawings.

The William F. Jenks Memorial Prize is given triennially by the College of Physicians of Philadelphia for the best essay on some announced gynæcological or obstetrical subject. It is of the value of about 100*l*. The essays are to be sent to the Chairman of the Prize Committee, from whom full particulars may be obtained. The last award was in January, 1901.

The three following prizes are given for essays on subjects connected with tropical diseases, which must be sent to the editors of the *Journal of Tropical Medicine* not later than December 7, 1901. An essay on the duration of the latency of malaria after primary infection as proved by tertian or quartan periodicity or demonstration of the parasite in the blood, for the Sivewright Prize; on the spread of plague from rat to rat and from rat to man by the rat-flea, for the Belilios Prize; and on the best method of administration of quinine as a preventive of malarial fever, for the Lady Macgregor Prize.

The Carmichael Prize is in the award of the President and Council of the Royal College of Surgeons in Ireland. It is of the value of 120*l.*, and is given for the best essay dealing with the state of the medical profession in Great Britain and Ireland.

The British Medical Association has instituted two Research Scholarships, awarded annually but capable of being continued for three years, each of the yearly value of 150*l.* These are for the encouragement of research in anatomy, physiology, pathology, bacteriology, State Medicine, clinical medicine, and clinical surgery. They are awarded by the Council of the Association on the recommendation of the Scientific Grants Committee.

The Association has also established an Ernest Hart Memorial Scholarship of the annual value of 200*l.*, the holder of which is required to devote himself to the study of some subject in the department of State Medicine. Forms of application for these scholarships may be obtained from the General Secretary of the Association.

The Grocers' Company have instituted three Medical Research Scholarships, open to all British subjects, of the annual value of 250*l.* They are intended as an encouragement to the making of exact researches into the causes and prevention of important diseases.

At Cambridge there are at least two valuable studentships in science, each of the annual value of 200*l.* and tenable for three years. One is the Balfour Studentship for original research in biology, and especially in animal morphology; and the other the John Lucas Walker Studentship for original research in pathology. At Trinity College the Coutts Trotter Studentship is open in physiology and experimental physics.

In connection with the Jenner Institute of Preventive Medicine a studentship of the value of 150*l.* has been offered. It is open to all British, including Colonial, subjects; it is tenable for one year and is renewable for a second year. It has been instituted for the purpose of research in pathological chemistry.

The Salters' Company Research Fellowship, of the annual value of 100*l.*, is for the promotion of research in pharmacology. It is awarded by the Company on the nomination of the treasurer of St. Thomas's Hospital and a Committee of Selection. It may be held for a term of three years, and the research must be prosecuted in the laboratories of St. Thomas's Hospital.

In connection with University College, Liverpool, are the Alexandra Fellowship in pathology, which was instituted in 1899 for a period of five years, and is of the annual value of 100*l.*; and the Colonial Fellowship in pathology and bacteriology, for which there is a preference for members of Colonial universities and medical schools.

The Walker Prize of the Royal College of Surgeons is awarded every five years for the best work in advancing the knowledge of the pathology and therapeutics of cancer. It is of the value of 100*l.* It is open to foreigners as well as British subjects, and it is not intended that essays should be written specially for the competition.

The John Tomes Prize is awarded triennially by the Royal College of Surgeons for original work on dental surgery, pathology, anatomy, physiology, or mechanics. The next award is for the period ending December 31, 1902.

The Cameron Prize, which is of the value of about 100*l.*, is given annually by the University of Edinburgh to the member of the medical profession who shall be adjudged to have made the most valuable addition to medical therapeutics during the year preceding.

The Marshall Hall Prize is given every five years by the Royal Medical and Chirurgical Society for physiological and pathological researches relating to the nervous system.

The Alvarenga Prize of the College of Physicians of Philadelphia, of the value of 36*l.*, is awarded annually for the best essay on any subject in medicine not already published. The essays, bearing a motto but no name, are to be sent to the secretary on or before May 1 of each year, and the award is made about July 14 following. A second is given by the Académie de Médicine in Paris, and a third by the Hufeland Society in Berlin, a fourth in Belgium, and a fifth by the Misericordia Hospital of Lisbon.

The Riberi Prize, which is of the value of 800*l.*, is offered by the Royal Medical Academy of Turin for original work in anatomy, physiology, pathology, or pharmacology. Research on the history of medicine since the Renaissance may also be submitted. The account of the research must be written in Latin, French, or Italian, and is to be sent to the secretary of the Academy. The prize is awarded for work done during the previous five years, and the last award was made in 1897.

The Bressa Prize of the Royal Academy of Science, Turin, is of the value of about 400*l.*, and is given for the most important scientific work produced during a given term of years. The last award was made in 1899.

The Vallauri Prize, of the value of 1,200*l.*, is in the gift of the Royal Academy of Sciences of Turin, and will be awarded to the scientific investigator, Italian or foreign, who within the period of four years from January 1, 1899, to December 31, 1902, shall be considered to have published the most noteworthy work on any of the physical sciences, taking that term in its widest sense.

One of the Nobel Prizes is awarded by the Carolinian Institute in Stockholm to the person who has been adjudged to have made the most important discovery in physiology or medicine during the preceding year. Recently two prizes, each of the value of about 11,000*l.* sterling, have been awarded by the Nobel Institute, one to Prof. Finsen, the founder of the Medical Light Institute at Copenhagen, and the other to Prof. Pawlow, of St. Petersburg, for his researches in regard to nutrition.

About thirty open prizes are offered each year by the Académie de Médecine of Paris, of which the most valuable is the François-Joseph Audiffred Prize. This is of the value of 1,000*l.*, and is offered to any person, without distinction of nationality or profession, who in the opinion of the Académie de Médecine is rightly adjudged to have discovered a preventive or cure of tuberculosis. The following are also among the more important offered for the year ending with the end of February, 1902; the sum specified in each case does not necessarily go to one candidate, but may be divided. The Academy Prize, awarded annually, worth about 40*l.*, is this year for a research on the *rôle* of toxins in pathology; the Baillarger Prize, of about 80*l.* (biennial), is for the best work on the treatment of mental diseases and the organisation of asylums; and the Charles Boullard Prize, also biennial, of 50*l.*, is for a similar subject. The Barbier Prize, of 80*l.* (biennial), is for the discovery of a cure for such "incurable" maladies as hydrophobia, cancer, epilepsy, typhoid and cholera. The Mathieu Bourceret Prize, of 50*l.* (annual), is for work on the circulation of the blood. The Campbell Dupierris Prize (biennial), of the value of 96*l.*, is for the best work on anæsthesia or the diseases of the urinary passages. The Chevillon Prize (annual), of 65*l.*, is for the best work on the treatment of cancer. The Desportes Prize, of 55*l.* (annual), will be awarded for the best work on practical medical therapeutics. The Herpin (of Metz) Prize (quadrennial), of 50*l.*, is offered for a research on the abortive treatment of tetanus. The Theodore Herpin (of Geneva) Prize, of 125*l.* (annual), is for a research on epilepsy and nervous diseases. The Laborie Prize, of 210*l.* (annual), is given for the greatest advancement in surgical science during the year. The Lefèvre Prize (triennial), of 75*l.*, is for a research on melancholia. The Meynot Prize (annual), of 108*l.*, is for the best work on ear disease; and the Saintour Prize (biennial), of 166*l.*, for the best work on any subject in medicine.

CHEMISTRY AT THE BRITISH ASSOCIATION.

In spite of the fact that a number of papers of general interest were contributed to Section B at the Glasgow meeting, the attendance was not so good as at the Bradford meeting last year. After the reading of the presidential address, a paper was read on duty-free alcohol by Dr. W. T. Lawrence, in which it was advocated that the Government should permit the use of non-methylated alcohol which had not paid duty for scientific purposes. In the course of the ensuing discussion, Dr. T. E. Thorpe drew attention to some of the difficulties with which the Excise Department would have to cope if such a course were permitted, and Prof. A. Michael, of Boston, stated that the United States Government allowed the use of non-methylated duty-free alcohol for scientific purposes and did not seem to meet with administrative difficulties. Dr. A. G. Green presented a comprehensive statistical report on the coal-tar industry, in which the progress made in this industry in Germany during recent years was strongly contrasted with its decadence in this country. The report of the Committee on preparing a new series of wave-length tables of the spectra of the elements was presented. Prof. Adrian Brown contributed a paper on enzymic action, in which he quoted the experimental results of an investigation of the action of invertase on cane sugar ; these results confirm the conclusion of previous workers that the action of inversion does not follow the simple law of mass action, but the author does not regard the action as independent of mass influence. He considers that the influence of mass in inversion changes is restricted by some other and hitherto unrecognised influence, and this he believes he has found in the time factor of molecular change. In reply to remarks by Prof. Reynolds Green, the author stated that his results were not necessarily in disaccord with those of Croft Hill. A paper was read by Prof. E. A. Letts and Mr. R. F. Blake, on the chemical and biological changes occurring during the treatment of sewage by the so-called bacteria beds. A large portion of the unoxidised nitrogen present in sewage disappears during the passage of the sewage through the so-called bacteria beds, and the authors consider that this may be due either to escape of the nitrogen in the gaseous state as free nitrogen or possibly as oxides or to the passage of the nitrogen into the tissues of animals or vegetables; both of these causes of loss may operate at the same time. An examination of sewage matter before and after passage through the beds showed that in nearly all cases the amount of dissolved nitrogen present in the sewage was greater after treatment than before, although, of course, if free nitrogen were evolved, only a minute fraction of it would remain dissolved in the sewage effluent. With respect to the possible biological explanation of the loss, it is pointed out that the sewage beds at Belfast and other places swarm with minute insects (*Podura aquatica*), and that species of worms are also present ; these in feeding on the sewage undoubtedly cause a loss of nitrogen. A paper was then read by Dr. S. Rideal on humus and the so-called irreducible residue in bacterial treatment of sewage, in which the results were detailed of a number of analyses of the humus-like substance or so-called irreducible residue produced in bacterial sewage beds. It is shown that in this material the ratio of carbon to nitrogen and the percentage of nitrogen in the organic matter present are very nearly the same as in humus mould ; the conclusion is drawn that if sewage has undergone proper bacterial fermentation the small quantity of peaty deposit formed is of the nature of humus and is practically inoffensive. In a paper on sulphuric acid as a typhoid disinfectant, Dr. S. Rideal advocated the use of sulphuric acid, either as such or in a more portable form as sodium bisulphate, for destroying the *Bacillus typhosus* in potable waters or in drainage from isolation hospitals. Mr. W. Ackroyd gave a paper on the inverse ratio of chlorine to rainfall, in which it was shown that when the observation periods are shortened to daily estimations of the chlorine, minimal amounts of rainfall are marked by maximum contents of chlorine, and *vice versâ*. In a second paper, Mr. Ackroyd dealt with the distribution of chlorine in Yorkshire. Mr. G. T. Beilby, in a paper on the minute structure of metals, showed that the microscopic examination of metallic surfaces has revealed that metals occur in two forms, viz., as minute scales or "spicules" (*a*) and as a transparent glass-like substance (*b*). The spicules do not vary much in size in the different metals and have a diameter of 1/300 to 1/400 of a millimetre ; the form *a* passes into the form *b* when the metal is pressed or hammered, and all polished metallic surfaces are covered with a thin layer of this transparent form as with a lacquer or enamel. Prof. G. G. Henderson and Mr. G. T. Beilby read a paper on the action of ammonia on metals at high temperatures ; on exposing platinum, copper, gold, silver, iron, nickel and cobalt to ammonia gas at 600° to 900° disintegration of the metal occurs, whilst a large proportion of the ammonia is decomposed into its elements. After the treatment the metal shows a spongy or cellular structure, as if it had been rapidly cooled whilst in a state of effervescence ; copper and iron rods of a quarter of an inch diameter are penetrated to the centre by the ammonia gas within half an hour, and copper exposed to the action of ammonia gas for seven days at 800° falls to a fine powder. Dr. W. C. Anderson and Mr. G. Lean gave a paper on aluminium-tin alloys, in which they show that these alloys evolve hydrogen freely when placed in water ; the microscopic examination of the water-corroded plates of alloy indicates that contact action between the excess of tin and the aluminium-tin compound is responsible for the spontaneous oxidation. Prof. Willy Marckwald, of Berlin, gave a very interesting demonstration and description of the properties of radium ; he had surmised, from the work of P. and S. Curie, that the barium salt extracted from pitchblende contains the radium salt as an isomorphous constituent, and that the process used by these workers for separating a strongly radio-active salt from the barium compound is probably similar to that in use for isolating the constituents of an isomorphous mixture. He therefore fractionally crystallised the barium chloride prepared from pitchblende from water, and found that pure barium chloride first separates and then a material, probably the eutectic mixture, which is very rich in the radio-active component. The most strongly radio-active fractions have the power of immediately discharging a charged gold leaf electroscope when at the distance of half a metre from the latter and when preserved under colourless glass soon turn it a deep brown colour. The radio-active substance is strongly luminescent in a dark room, and on interposing the hand between the preparation and a barium platino-cyanide screen, the bones in the fingers are seen sharply delineated on the screen. Prof. Marckwald also exhibited several preparations of so-called "phototropic" substances, compounds which change colour on exposure to sunlight and recover their original tint on preservation in a dark place ; he mentioned that the rapidity of change in either direction is considerably influenced by the temperature. Prof. A. Michael, of Boston, read papers on the genesis of matter and on the process of substitution ; he also contributed a paper on the three stereoisomeric cinnamic acids, in which he claimed to have proved that these three isomerides actually exist, that is, that one more isomeride exists than can be accounted for by the van 't Hoff hypothesis as interpreted by Wislicenus. Prof. G. G. Henderson and Mr. Corstorphine read a paper on the condensation of benzil with dibenzylketone ; in this condensation a tetraphenylcyclopentenolone is produced, and on heating it with red phosphorus and hydriodic acid a mixture of tetraphenylcyclopentene and tetraphenylcyclopentane is formed. Dr. Hodgkinson and Mr. L. Limpach contributed a paper on some relations between physical constants and constitution in benzenoid amines, and Dr. G. Young gave a paper on the existence of certain semicarbazides in more than one modification. Prof. W. H. Perkin, jun., gave a brief outline of his work on the synthetical formation of bridged rings. Prof. Joji Sakurai, of Tokio, in a paper on some points in chemical education, observed that in spite of the rapid progress made in chemistry during the past fifteen years, chemical education seemed still to be carried out in an inefficient and unsatisfactory manner. He pleaded for the more extensive use of physical chemistry as an educational agent, but wished to replace the ordinary name of this branch of the subject by the more rational one of general chemistry. Mr. W. Thomson contributed a paper on the detection and estimation of arsenic in beer and articles of food ; after noting that arsenic is introduced into barley during the process of malting owing to the employment of anthracite coal or coke containing arsenic, he suggested that all beers in 50 c.c. of which arsenic could be detected by any test whatever should be condemned. In a report entitled "The Equilibrium Law as Applied to Salt Separation and to the Formation of Oceanic Salt Deposits," Dr. E. F. Armstrong gave an excellent *résumé* of the work of van 't Hoff and his pupils on the investigation of the conditions attending the formation of the German deposits of magnesium salts ; the report was illustrated by the aid of a number of models. Dr. J. Gibson, in a paper on the electrolytic conductivity of halogen acid solutions, detailed the results of experiments which showed that halogen acid solutions of concentrations corresponding to a change of curvature of the electrolytic conductivity curve have altogether peculiar properties. Other papers were read by Mr. P. J. Hartog, on the flame coloration and spectrum of the nickel compounds, by Dr. Farmer, on the methods of determining the hydrolytic dissociation of salts, and by Dr. T. S. Patterson, on the influence of solvents on the rotation of optically active compounds.

ENGINEERING AT THE BRITISH ASSOCIATION.

SECTION G suffered badly at Glasgow, both in attendance and in the quality of the papers presented to it, from the Engineering Congress which was held in the University buildings during the preceding week ; many regular members of the Section were absent, and several valuable papers which would under ordinary circumstances have come to the Section were read instead at one or other of the Congress sectional meetings. On the opening day, after the presidential address, since the engineering departments of the Glasgow International Exhibition would naturally be frequently visited by members of the Section, it was arranged to have a paper descriptive of the mechanical exhibits; this was given by Mr. D. H. Morton, and proved most useful in assisting visitors to spend to the best advantage the hours they gave up to the Exhibition. The author, rightly enough, deplored the almost complete absence of any marine engineering exhibits and the poor show of locomotives; but he pointed out that in another of the great industries of Glasgow, steel making, there was a remarkably complete and most instructive series of exhibits, the enormous steel plates and huge steel forgings and castings being especially interesting. On the same day two interesting papers by Mr. J. R. Wigham, on a long-continuous-burning petroleum lamp for beacons and buoys, and on a new scintillating lighthouse light, were also read. In the first paper the author claimed that by burning petroleum and using the wick horizontally, so that the flame sprang from the side and not from the edge or ends, a steady light could be secured requiring no attention for a month; the slow continuous movement of the wick over the roller was secured by an ingenious arrangement in which the gradual escape of oil from a cylinder caused a float attached to the wick end to slowly descend, thus causing the wick to travel over the roller and so present a new surface to the flame. Examples of both these appliances were on show in the University buildings.

Another paper on this day was a short note by Mr. J. E. Petavel, in which he described a recording manometer he had devised, for obtaining a record of the high pressures reached by exploding charges of gas in closed cylinders. The instrument seemed well adapted for its purpose and ought to prove useful in gas and petroleum engine work.

Two reports were presented to the Section, one by the Small Screw Gauge Committee, in which the extreme trouble they had met with in obtaining accurate gauges was again described; and as a result practically little progress had been made since the last report was presented at Bradford; the other by the Committee on Resistance of Road Vehicles to Traction. This committee, which was appointed at Bradford, has discovered that the task it has embarked upon is a most difficult one, and one which will involve an expenditure far beyond any grants which could be given by the Association. The committee therefore sought and obtained authority to approach other bodies for financial help—many promises of substantial assistance had been given before the meeting. The work done up to date is briefly as follows:—(*a*) a dynamometer has been designed and is in course of construction; (*b*) a motor (lent by a member of the committee) is being fitted up to carry the dynamometer and is having a new and more powerful engine fitted to it; (*c*) it has been decided after careful consideration to begin the experiments by testing single wheels with various types of tyres, on artificial tracks, and then later on, with the experience gained in these preliminary investigations, the work on actual vehicles on ordinary roads will probably be much simplified. As some misapprehension exists as to the work the committee are attempting to carry out, it may be as well to state that it is work of the utmost value to the country, and work of a highly scientific character. No recent experiments have been carried out on this most important question, and designers of motor vehicles are obliged either to adopt rule of thumb methods or to fall back on data obtained by experiments made many years ago, on roads of quite different construction to those now in use, and with only one type of tyre, the solid steel or iron one. Should the committee succeed in the elaborate series of experiments they have planned, not only will designers of self-propelled vehicles have constants and data available for their use, upon which they can place absolute reliance, but road engineers will have exact information on two questions of the greatest interest to them, the effect of the method of moving a vehicle (that is, whether hauled of self-propelled) upon the life of a road, and secondly, the relative advantages of the different materials now in use for road making in regard to the frictional resistances encountered by the vehicles moving over them.

As the president of the Section devoted a part of his address to the modern development of passenger and goods traffic, it was natural that many of the papers read before the Section should deal directly or indirectly with this subject. Mr. N. D. Macdonald, in a paper on railway rolling stock present and future, attacked in vigorous fashion railway management in this country; he undoubtedly put his finger on many weak spots, notably as regards brakes and our old-fashioned goods trucks, but, like most amateurs when dealing with professional subjects, he spoilt much of his case by exaggeration. Professional engineers, like every other class of men, are liable to errors. They are prone to prefer old-fashioned methods and are too little inclined to take up and try novelties, but, after all, they are men of understanding and business men, and they are not likely to shut their eyes to improvements going on in other countries or to refuse to adopt them simply because foreigners first tried them. No one who travels much can fail to note the great improvements in railway management in this country during the past ten years, or the many changes still to be made if we are to keep abreast of the latest advances; but, after all, it is wiser to adopt radical changes cautiously, and we fancy the public will continue to place more reliance on the judgment of the trained expert than of the over-eager amateur.

Mr. Bunau-Varilla, formerly engineer-in-chief of the Panama Canal, in a paper on the canal, vigorously defended the judgment of those who selected that site for the canal instead of the Nicaragua route. The author gave many strong reasons for his preference for Panama; in particular he contrasted the almost entire freedom of the Panama site from seismic disturbances with the constant and ever-present danger to all concrete and masonry work all along the Nicaragua route from such causes. The case for Panama was so strongly put that it was unfortunate there was no real discussion on the paper, and therefore the arguments in favour of Nicaragua were not given a chance.

In electrical engineering, only two papers of much interest were presented, a valuable one by Prof. E. Wilson, on the commercial importance of aluminium, and a paper by Mr. Killingworth Hedges, on the protection of buildings from lightning. Prof. Wilson, after a brief description of the latest methods of manufacture, devoted himself mainly to an account of the use of aluminium as a conductor of electricity and its advantages for this purpose. In the discussion, the president (Colonel Crompton) referred to the great difficulty in securing uniform quality in aluminium tubes and sheets, and suggested that this stumbling-block must be removed if the extended uses of the metal which engineers hoped for were to become possible. Mr. K. Hedges drew attention to the work of the committee of British architects which was now engaged in considering the question of the protection of buildings from lightning effects, and to the urgent need of the adoption of some uniform system. He described in detail his re-arrangement of the system in use at St. Paul's Cathedral in London, where the conductors put up in 1872 were found to be quite useless for the purpose they were intended to serve. He had increased the number of ordinary conductors from air to earth, and, in addition, ran horizontal cables on the ridges of the roofs and in other prominent positions, thus encircling the building. These were connected to the vertical conductors wherever they crossed, and were also furnished at intervals with aigrettes or spikes, invisible from the ground level, thus giving many points of discharge. The author drew attention to the unsuitability of soldered joints for conductors, and described his own special joint box; he also explained the tubular earth he designed to get over the difficulties brought about by the old foundations of the cathedral interfering with the use of an ordinary earth plate. In the more purely mechanical side of its work, the Section dealt with two papers of much interest. Prof. George Forbes described his "folding rangefinder for infantry," and Mr. M. Barr the machines he had designed for the manufacture of type. Prof. Forbes' instrument is of the class known as "one-man portable-base range-finders," and possesses great accuracy up to a range of 3000 yards. It was founded on Adie's original instrument. It consists of a folding aluminium base of square tube, hinged at the centre, and a field glass. At each end of the base when opened out is a doubly reflecting prism, the rays of light from any object are reflected at each of these end prisms along each half tube, and then again at the centre into the two telescopes of the binocular glass, the final directions of the rays being parallel to the original. The angle between these rays is measured by means of two vertical wires, one in each telescope, one wire is fixed, and the other can be moved by a micrometer screw until the two appear to coincide and the object appears distinctly; the distance of the object is then at once given, to within 2 per cent. in 3000 yards. The author claimed great accuracy in stereoscopic vision, but Profs. Barr and Stroud, who took part in the discussion, and drew attention to the somewhat different lines on which they had worked in their range-finder (of which 400 are now in use in our Navy), differed on this point from him and preferred the method of single coincidence. Mr. Barr's paper, illustrated by lantern slides, was of too highly a technical nature to be dealt with in detail in the space at our disposal, suffice it to say it bids fair to revolutionise the method of carving or engraving the matrices used in type casting. The new process dispenses with wax and electro-plating processes, and secures a pattern cut out of solid brass in a much shorter time than was possible in any of the older methods. The author described the great difficulties he had met with in this work, both in the design of a strong, rigid and easily worked pantograph and in the attempt to carve out rapidly the large amount of superfluous material in the brass plate which had to be removed in order that the design should be left clearly in relief on a smooth plane; all these had now been overcome. Special machinery had been designed capable of extraordinary accuracy for cutting rapidly the punches needed, and for grinding the cutters.

The last paper we need refer to was one by Mr. C. R. Garrard on some recent developments in chain driving, which elicited a very interesting discussion, one of the best during the meeting. He gave figures as to the extraordinary pressure per square inch used in chain bearings as compared with those adopted in ordinary engineering work; in an ordinary bicycle chain as high a figure as 11,765 pounds per square inch may be occasionally reached; an account was given of the most recent methods of making these chains and of the quality of steel used, and, lastly, of the use of chains for high-speed driving purposes.

Apparently for the reason given before, local engineers took but little interest or share in the proceedings of the Section, and on the whole it was a disappointing meeting, both from the point of view of attendance and discussion on the papers and also in the quality and general value of the papers dealt with. Section G still calls in vain for papers from the numerous engineering laboratories throughout the kingdom; there are scores of young engineers, engaged in scientific research work, and until they can be got hold of, and the class of papers radically altered, Section G will fail to appeal to the great body of engineers in the country. T. H. B.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

THE Anthropological Section of the British Association met in the new Anatomy Department of the Glasgow University, which was formally opened by Lord Lister on the first afternoon of the meeting. The address of the president of the Section, Prof. D. J. Cunningham, F.R.S., dealt with the human brain, and the part which it has played in the evolution of man, and is to be found in full in NATURE of September 26, p. 539. The rest of the programme was planned as follows: Thursday morning and Monday afternoon were devoted to physical anthropology, which was represented by an unusual number of highly specialist papers; Tuesday to ethnography, chiefly American and Malayan; Friday and Monday morning to archæology; and Wednesday to anthropometry and folklore. The principal papers are classified below in order of their subject-matter.

Anthropography.

Prof. J. Cleland, F.R.S., gave a demonstration of the cartilage of the external ear in the monotremata in relation to the human ear, illustrated from *Echidna* and *Ornithorhynchus.*

Dr. J. F. Gemmill illustrated, by a series of fine microscope-projections, the origin of the cartilage of the *stapes* and its continuity with the hyoid arch, showing that the *stapes* is developed independently of the periotic capsule, and belongs to the hyoid bar.

Prof. A. Macalister, F.R.S., contributed notes on the morphology of transverse vertebral processes, with the object of determining embryologically the morphological relations of the several parts of the neural arch. A further note on the third occipital condyle showed that two distinct structures are comprised under this name—a mesial ossification in the sheath of the notochord, and a lateral and usually paired process caused by the deficiency of the mesial part of the hypochordal element of the hindmost occipital vertebra, with thickening of the lateral portion of the arch.

Principal Mackay read a paper on suprasternal bones in the human subject, which gave rise to an animated discussion of the embryological evidence.

Prof. J. Symington combated Hochstetter's view that the "temporary fissures" of the human cerebral hemispheres are merely the product of incipient maceration and putrefaction in laboratory specimens. He admitted, however, that the arcuate fissure is of no morphological significance, and that it has nothing to do with the hippocampal fissure, which latter can be traced in the fœtal brain in the position which it occupies throughout life in the monotremata and marsupialia. The rudimentary grey and white matter on the back of the adult human *corpus callosum* is probably the remains of a hippocampal formation.

Mr. J. F. Tocher and Mr. J. Gray discussed the frequency and pigmentation value of the surnames of Scottish school-children in East Aberdeenshire. There is a presumption that the present possessors of surnames inherit some of the physical characteristics of their ancestors of the thirteenth and fourteenth centuries, when hereditary surnames first became common in Scotland, and this is confirmed by the fact that among 751 surnames noted, 63 Highland names covered 13 to 14 per cent. of the population; the same proportion of Highland blood as had been previously ascertained by measurements. There is wide variability in the pigmentation value of different surnames; Frasers, for example (from blonde Inverness-shire), tending to be blonde; and Robertsons and Gordons (from Perthshire and West Aberdeenshire) to be dark. A committee of the Association was appointed to assist Messrs. Gray and Tocher in organising a similar pigmentation-survey for the school-children of the rest of Scotland.

Miss Nina Layard exhibited a skull found in peat in the bed of the river Orwell, now in the museum of the College of Surgeons. It proved to be of the same pre-Roman British type which is common in the Fen district.

Mr. W. M. Douglas, superintendent of police, described the working of the Bertillon method of personal identification, as practised in Glasgow. In discussion, Dr. Garson laid stress on the value of the form of nose and ear in identification, as against the colour of hair and eye; pronouncing photographs useless, but finger prints most important.

Ethnography.

The Report of the Ethnographic Survey of Canada summarised the work of the year, and introduced a copious memorandum by Mr. C. Hill Tout on the natives of British Columbia. The committee was reappointed with a grant of 15*l*. Mr. J. O. Brant Sero, a Canadian Mohawk, gave an account of the traditional history of the Caniengahakas and their culture-hero Dekanawideh, with notes on their social and political organisation. This striking communication is printed in full in *Man* for November.

Mr. Hesketh Prichard described in detail the manners and customs of the Tehuelche Indians of Patagonia, and Mr. Seymour Hawtrey those of the Lengua Indians of the Gran Chaco.

The Report of the Skeat Expedition to the Malay Peninsula contained an elaborate account of Malay industries, and was illustrated by photographs and reproductions of native implements and fabrics. Mr. Skeat contributed a detailed study of the Sakais and Samangs, wild tribes in the interior of the Peninsula who retain many marks of a primitive stage of culture.

Messrs. Annandale and Robinson, who are still in the field, sent a full account of the half-Siamese half-Malay community of Sai-Kau in the northerly border-state of Nawnchik, in which the two peoples live side by side and have given rise to a mixed type of culture. Physical measurements show the survival in both of a marked Negrito element.

Mr. R. Shelford propounded a provisional classification of the swords of the tribes of Sarawak.

Dr. W. H. R. Rivers discussed the functions of the maternal-uncle, son-in-law and brother-in-law in Torres Straits, with the view of illustrating the underlying principles and the practical working of certain phases of primitive society.

Mr. C. S. Myers analysed the emotional life of the inhabitants of Murray Island, which he studied in the course of the Cambridge expedition to Torres Strait. The excitability of the native is due rather to the varying sanctions of society than to distinctive mental constitution.

Mr. W. Crooke described the organisation of the projected Ethnographic Survey of India and offered criticisms in detail, regretting, in particular, that it had not been found possible to provide for systematic photography of native types, occupations and ceremonies.

Mr. R. A. S. Macalister gave an account of the customs, ceremonies and beliefs of the Fellahin of Western Palestine.

Mr. D. MacRitchie, under the title "Hints of Evolution in Tradition," discussed the value of the widespread stories of giants, dwarfs, fairies and hairy folk as evidence of the survival of primitive types of mankind in remote localities until comparatively recent times.

Mr. J. S. Stuart Glennie criticised Dr. Frazer's views of the relations between magic, religion and science, as expressed in the second edition of the "Golden Bough." The new stage which Dr. Frazer named "science" would give a higher and more verifiable form to the common ideal and social observances which constituted religion.

Archaeology.

Dr. W. Allen Sturge opened a discussion on the chronology of the Stone Age of man, with especial reference to his coexistence with an Ice Age, laying stress on the evidence of patination as a test of relative age, and exhibiting a series of implements which appeared to show traces of reworking after a prolonged interval, and also scratches on a patinated surface, which he claimed to be due to ice-movement. In discussion, Sir John Evans pointed out that patination is not always a safe guide as to relative age; and Prof. Kendal and others held that scratches similar to those exhibited are produced by small local movements in the mass of a gravel-bed.

Mr. Coffey attacked the same question from another side by an exhibit of naturally chipped flints from the Larne gravels and North Irish beaches, which so closely resembled the chipping of the alleged "Eolithic" implements as to prevent any certain conclusion being reached as to what really is artificial chipping.

Miss Layard exhibited a flint palæolith with alleged "thong-marks," which seemed, however, to be patches of the rough skin of the nodule; and also a series of implements of stone and horn from the neighbourhood of Ipswich.

Mr. F. D. Longe exhibited a piece of yew from the forest bed near Kessingland, showing cuts made by a straight-edged instrument. Doubts were, however, expressed as to the antiquity of the cuts.

The Report on the age of stone circles gave full particulars of excavations conducted by the committee at Arbor Low. The occurrence of a Bronze Age interment-barrow *on* the rampart of the circle gave a downward limit of date for the latter, and the discovery of flint flakes and other objects *in situ* went far to determine an upward limit. Further investigation, however, is required, and the committee was reappointed with a grant of 30*l*.

An important paper on excavations on Neolithic sites in the Isle of Arran was contributed by Drs. Duncan and Bryce. The results show that the mere presence of stone implements affords no test of the archæological horizon, but that the pottery found in the "Megalithic cists serially arranged" distinguishes these as earlier than the short cists in cairns or circles, and as truly Neolithic. No traces of cremation were found; but only a few of the human remains were in a condition for examination. The cephalic indices of four individuals were 66·6, 70, 75, 75·5, and the anatomical characters were identical with those of the English "long-barrow" folk. The paper will be published in full in *Proc.* Soc. Antiq. Scot., and the anthropographic material in *Journ.* Anthr. Inst.

Dr. Munro gave an account of a "kitchen midden" excavated near Elie, in Fife, which was proved to occupy the site of a wooden house belonging to pastoral or hunting people, and to belong to the eighth century, A.D. (cf. *Proc.* Soc. Antiq. Scot. xxxiv.)

Mr. J. H. Cunningham described the excavation by the Scottish Society of Antiquaries of the Roman station at Ardoch in Perthshire; the results are published fully in *Proc.* Soc. Antiq. Scot., xxxii. Mr. Thomas Ross described the recent excavation of the Roman camp at Inchtuthill.

The Report of the Silchester Excavation Committee recorded the clearance of four fresh *insulae* (xxiii–xxvi) and the discovery of some interesting pavements, and of a large hoard of smith's tools. The Committee was reappointed with a grant of 5*l*. and a similar committee was granted to cooperate with the Cardiff Naturalists' Club in excavation at Gelligaer.

Mr. R. A. S. Macalister discussed the external evidence bearing on the age of Ogham writing in Ireland, pointing out that certain Ogham inscriptions occur in association with tumuli, circles, and alignments, on stones with non-Christian symbolism, or in other circumstances which suggest a pre-Christian origin for the Ogham script.

Mr. James Paton gave a demonstration of Scottish antiquities in the Art Gallery of the Glasgow Exhibition; an innovation which was fully justified by the result, and might be repeated elsewhere with advantage.

Mr. C. S. Myers described the bones of Hen Nekht, an Egyptian king of the third dynasty, who was of giant stature (1870 mm.), and identified him with the gigantic king recorded diversely by Manetho as penultimate king of the second dynasty, and by Eratosthenes as first king of the third.

The Report of the Cretan Exploration Committee summarised the results of excavation on Mycenæan sites at Knossos, Zakro and Præsos in the seasons 1900 and 1901. At Knossos the remains of a splendid palace have yielded a large number of fragmentary fresco paintings, many works of art in bronze, stone and pottery, and a great wealth of clay tablets inscribed in Ægean hieroglyphic and linear characters. The excavations at Knossos demand another season's work, and the Committee was reappointed, with a further grant of 100*l*.

Mr. A. J. Evans, F.R.S., supplemented the Report with a description of the Neolithic settlement which underlies the Mycenæan palace at Knossos, drawing particular attention to the stone mace heads and small human figures in clay and marble, which seemed to him to present Anatolian analogies, and to indicate intercommunication between the Ægean and Babylonia. The Neolithic culture of the Ægean presents points of strong contrast with that of the Bronze Age; and the absence as yet of spiraliform ornament confirms the opinion that this motive was introduced into the Ægean at a later date, and probably from Egypt.

Mr. Bosanquet gave a detailed account of the excavations on the site of Præsos, the ancient capital of eastern Crete. Two large sanctuaries were discovered, together with an "andreion" or public dining-hall, of Hellenistic date, and a remarkable inscription written in Greek characters of the fifth century, but composed in the Eteocretan language.

Mr. Hogarth contributed a description of a Mycenæan site excavated by him at Zakro on the east coast of Crete, with houses, tombs, much pottery of new types, and a deposit of clay impressions from Mycenæan seal-stones.

Mr. R. A. S. Macalister described the result of several seasons' excavation on small sites in western Palestine, which throw important light on the civilisation of the early Israelites and of Philistia.

Interim reports were received from the committees on anthropological photographs and on the present state of anthropological teaching. A new committee was appointed, with Prof. Macalister, F.R.S., as chairman, Mr. C. S. Myers as secretary, and a grant of 15*l*. to conduct anthropometric observations among the native troops of the Egyptian army.

BOTANY AT THE BRITISH ASSOCIATION.

AFTER the delivery of the presidential address by Prof. Bayley Balfour, F.R.S., Dr. Lotsy (Hilbersum, near Arnhem, Holland) explained to the Section the aims and proposals of the International Association of Botanists, which was founded at Geneva in August. The Association has purchased the *Botanisches Centralblatt*, which it proposes to conduct as a first-class review of current botanical literature. Dr. Lotsy pointed out that an increased number of subscribers and shareholders is desired in order to ensure success. On Saturday the members of the Section were invited by the President to the Edinburgh Royal Botanic Garden, where they inspected the museum and garden and were afterwards entertained at lunch by Prof. and Mrs. Bayley Balfour. The excellence of the museum preparations was a striking feature, particularly the specimens and dissections preserved in spirit and labelled for teaching purposes. A very useful paper was read before the Section by Mr. Tagg, in which he gave an account of the methods employed by him with conspicuous success in the Edinburgh Museum in preserving and preparing plants for museum purposes.

On Friday afternoon Prof. Reynolds Green, F.R.S., delivered a lecture on flesh-eating plants. Monday morning was devoted to a joint discussion (Botanical and Educational

Sections) on the teaching of botany, an account of which has appeared in the report of the work of the latter Section. Mr. A. G. Tansley described the vegetation of Mount Ophir and gave a lantern exhibition of several photographs which he had taken during a recent expedition to the Malay Peninsula. The views of dense masses of *Matonia pectinata*, *Dipteris conjugata* and *D. Lobbiana* growing in the Mount Ophir region were particularly striking as illustrating the present home of these isolated fern genera which played a prominent part in European vegetation during the Mesozoic epoch. Some excellent botanical photographs from the Malay Peninsula were also exhibited by Mr. Yapp, who acted for some months as botanist to the Skeat Expedition.

Thallophyta.—Cytology of the Cyanophyceæ, by Harold Wager. The researches of Scott, Zacharias, and others have definitely revealed the fact that the contents of the cells of the Cyanophyceæ are differentiated into two distinct portions, an outer peripheral layer in which the colouring matters are placed, and a central colourless portion which is usually spoken of as the "central body." The central body is regarded by many observers, and notably by Bütschli, as a true nucleus. According to the author's observations, it appears to resemble the nuclei of higher organisms, in that it is composed of a chromatic network, but it differs from them in the absence of a nuclear membrane and nucleolus. Staining and other reactions show that chromatin is present, but in most cases only in small quantities. The presence of phosphorus in the central body can also be demonstrated, as Macallum has shown, by means of the molybdate phenylhydrazine reaction. In the process of division the cell begins to divide and new cell-walls are formed independently of the division of the nucleus. In the process of nuclear division the chromatin threads become drawn out longitudinally and parallel to one another, and are then divided transversely. Some of the division stages, especially in elongate cells, resemble stages in true karyokinetic division.

The Bromes and their brown rust, by Prof. Marshall Ward, F.R.S. The author has been for some time occupied with the grasses of the genus *Bromus* and the behaviour of the *Uredo* of the brown rust (*Puccinia dispersa*) upon them. The plan of the investigation includes the nature of infection and conditions of attack, and all discoverable relations between host and parasite. The germination of the grass seeds has led to interesting points. They can be treated antiseptically in various ways and grown as pure cultures in nutritive solutions in glass tubes of various shapes, designed either to allow of the continuous aëration of the plantlet by a current of filtered air drawn through by aspirators, or not.

Such pure cultures of the grass were then infected with uredo-spores, and in ten to twelve days gave rise to *pure cultures of the Uredo*, which germinated and infected other similarly pure cultures of the grass inoculated with them.

Long series of sowings were made to test the conditions of germination of the uredo-spores. The minima and maxima temperatures of germination were found to be about 10° C. and 27°·5 C. respectively, the optimum being about 18° C. The effects of light, of other organisms (*e.g.* Algæ), of various extracts, and of the age of spores, &c., were also examined. Infection experiments on pot plants were made—several hundreds in all—on twenty-one species or varieties of *Bromus*.

The general results are, put very shortly, as follows:—Although the *Uredo* examined is in all morphological respects absolutely identical on all the species of *Bromus* on which it occurs, nevertheless if spores gathered from *B. sterilis* are sown on *B. mollis* the infection fails, whereas spores of the same batch sown on *B. sterilis* infect normally and rapidly. And similarly in other cases. Spores from *B. mollis* readily infect *B. mollis*, and (less certainly) its allies *B. secalinus* and *B. velutinus*, *B. arvensis* and others of the *Serrafalcus* group; but they fail on *B. maximus*, *B. tectorum*, *B. sterilis*, *B. madritensis*, &c.—the *Stenobromus* group—and so with other cases.

These observations lend no support to either the mycoplasm theory of Eriksson, or to any theory which attempts to explain outbreaks of rust to intra-seminal infection handed down from parent to offspring, and the author believes that the difficulties hitherto met with in understanding the sudden epidemics of these rust-diseases will disappear as we gain exact information of the conditions of germination, infection, and incubation of the disease-producing parasite; as also of its habits of lurking in the older leaves of the grass in spots where the production of a very few spores—quite invisible on a casual overhauling of the grass—prepares the way for more extensive infection as the weather changes.

Prof. Marshall Ward, F.R.S., communicated a paper by Mr. T. Barker on spore-formation in yeasts, also an account, by Mr. Howard, of a *Diplodia* parasitic on cacao and on the sugar-cane.

Pteridophyta.—Contributions to our knowledge of the gametophyte in the Ophioglossales and Lycopodiales, by William H. Lang. (1) The prothalli of *Ophioglossum pendulum* and *Helminthostachys zeylanica*. The wholly saprophytic prothallus o *O. pendulum* is at first button-shaped, but by branching the older prothalli come to consist of a number of short cylindrical branches radiating into the humus. The young prothallus and the branches are radially symmetrical. In the older parts all the cells except the superficial layers contain an endophytic fungus. The prothallus is monœcious. The antheridia are sunken, with a slightly convex outer wall one layer of cells thick; in surface view this shows a triangular opercular cell. The neck of the archegonium, which projects very slightly, consists of about sixteen cells in four rows. The central series in all archegonia yet observed consists of an ovum and a single canal cell. A basal cell is present. The prothalli of *Helminthostachys* were found a few inches below the surface of the soil in a frequently flooded jungle in Ceylon. The prothalli are radially symmetrical. The smallest were stout cylindrical structures the lower part of which was darker in tint and bore rhizoids; the upper bore the sexual organs, which arise acropetally behind the conical apical region. In prothalli which bear archegonia the vegetative region is relatively more developed, and in both these and the male prothalli it becomes more or less lobed. The antheridia are large and sunken; the slightly convex outer wall is two-layered except at the places where dehiscence may occur, which consist of single large cells. The archegonia have a neck, consisting of four rows of cells, which projects considerably.

(2) On the mode of occurrence of the prothallus of *Lycopodium selago* at Clova. The sporophyte of this plant is very common on moors, screes and crags in the Clova valley, and in these situations it seems to be reproduced almost entirely by means of bulbils. On the sometimes submerged margin of Loch Brandy, however, numerous sexually produced plants and prothalli may be found growing in the soil between the stones. The difference in the conditions under which the sporophyte can exist and those necessary for the successful germination of the spores is analogous to what has been found to be the case for *Helminthostachys*.

(3) On some large prothalli of *Lycopodium cernuum*. The prothalli of this plant, described by Treub, were of small size, one of the largest measuring 2 mm. in height by 1 mm. across. On the banks of roads close to Kuala Lumpur much larger prothalli were found. They were cake-like structures, of a deep velvety green colour, about 2 mm. in vertical thickness, but measuring sometimes 6 mm. across: they were attached to the soil by numerous rhizoids springing from the flat base.

(4) On the prothallus of *Psilotum*. The prothallus of this plant was searched for without success in Ceylon. The sporophyte occurred on tree-fern trunks on Maxwell's Hill in Perak, and a single prothallus was found there embedded among the roots of a tree-fern close to a *Psilotum* plant. No other plants grew on this tree-fern, and, although a few species of *Lycopodium* occur sparingly in the locality, there seems a strong probability in favour of this specimen being the prothallus of *Psilotum*. The specimen measured one quarter of an inch in height by $\frac{3}{16}$ inch across at the widest part. It consists of a cylindrical lower region covered with rhizoids; near the lower end of this is a well-marked conical projection (primary tubercle). The upper part widens out suddenly, and its thick overhanging margin bears numerous antheridia. In general form the prothallus resembles some small specimens of *Lycopodium cernuum*, but the upper region, from which assimilating lobes are absent, finds its closest analogue in prothalli of *L. clavatum*.

Some observations upon the vascular anatomy of the Cyatheaceæ, by D. T. Gwynne-Vaughan. In a number of Dicksonias with creeping or prostrate stems the vascular system is solenostelic, the leaf-traces departing as a single strand curved into the form of a horse-shoe, with its concavity facing towards the median line of the rhizome—*Dicksonia adiantoides*, *cicutaria*, *davallioides*, *apiifolia*, and *punctiloba*. In *Dicksonia rubiginosa* the vascular ring is interrupted by gaps other than those due to the leaf-traces, and it may therefore be termed polystelic. In addition, there are two or three small accessory steles lying within the vascular ring. Throughout the internode the course of these internal steles is quite free from the vascular ring, but at each node one of them approaches the free margin of the leaf-gap, and completely fuses with it, separating off again after the leaf-gap has become filled up. *Pteris elata* var. *Karsteniana* has a typically solenostelic vascular ring, and also possesses internal accessory steles, which behave like those of *Dicksonia rubiginosa*, but they are relatively larger, and frequently they all fuse up together so as to form a second, inner, completely closed vascular ring. It is suggested that the several internal steles and vascular rings that occur in the Saccolomas and in *Matonia pectinata* are also of the same origin and nature as those described by the author.

Prof. Bower, F.R.S., exhibited a specimen of *Ophioglossum simplex*, n. sp., collected by Mr. Ridley in Sumatra. It appears to be entirely without the sterile leaf-lobe, though the fertile spike is characteristically that of an *Ophioglossum*. If it be actually demonstrated that the sterile lobe is really absent, this peculiar plant may give rise to considerable morphological discussion.

The anatomy of *Ceratopteris thalictroides*, by Sibille O. Ford. *Ceratopteris thalictroides* is the single member of the Parkeriaceæ. It is an annual aquatic fern which occurs in the tropics, either rooted in the mud or floating freely. The stem is much reduced; sterile as well as fertile leaves are found, both kinds bearing numerous vegetative buds. The sporangia are scattered on the under side of the fertile leaves, and have no true indusium. The roots in the mature plant arise from the bases of the petioles. An account was given of the anatomy of the leaves, roots and polystelic stem. The apex of the stem was described as having the form of a cone terminating in a three-sided cell. Miss Ford spoke of *Ceratopteris* as possessing more strongly marked affinities with the Polypodiaceæ than with any other of the leptosporangiate ferns, and as possibly intermediate in position between the Marsiliaceæ and Polypodiaceæ.

On two Malayan "myrmecophilous" ferns, by R. H. Yapp. *Polypodium* (*Lecanopteris*) *carnosum* and *Polypodium sinuosum* are two epiphytic ferns, which occur almost exclusively in the Malay Peninsula and Archipelago. Their creeping rhizomes are thick and fleshy, the ventral surface closely adhering to the substratum, the dorsal bearing the leaves, which are articulated upon large conical leaf-cushions. Branching is lateral, and is so frequent in the case of *Polypodium carnosum* that thick compact masses of interlacing stems are formed, which completely encircle the branches of the trees on which the fern grows. The fleshy stems of both ferns are traversed by an extensive system of hollow spaces, which are invariably inhabited by colonies of ants. These "ant-galleries" are arranged on a perfectly definite plan, the details of which differs to some extent in the two ferns. In both cases there is a single main ventral gallery, which runs in a longitudinal direction through the stem, giving off a lateral gallery to each branch and a dorsal one to each leaf-cushion. The galleries are formed by the breaking down of a large-celled, thin-walled tissue, which in the youngest parts of the stem appears to function as a water-reservoir. Though undoubtedly closely allied species, these ferns have been placed by many authorities in different genera.

Mr. George Brebner gave an account of the anatomy of *Danaea* and other Marattiaceæ. In *Danaea simplicifolia* the primary vascular axis is a simple concentric stele. The pericycle may be absent or only imperfectly represented. There is a definite endodermis, but it is not clear that the constituent cells are always the innermost ones of the extrastelar tissue. When the cotyledon-trace is about to be given off, the xylem of this vascular axis, or "protostele," is separated into more or less unequal portions by a layer of parenchyma. The parenchyma increases in amount, and ultimately the cotyledon-trace is separated from the central stele. The cotyledon-trace is collateral. The next few leaf-traces are given off in the same manner, and are also collateral. The stele resumes its simple "protostelic" appearance. As further leaf-traces depart from, and root-traces join, the vascular axis, the primitive structure is gradually modified, and it may become more or less crescentic, forming an incomplete, or even complete, gamostelic ring. The spaces left by the departure of the leaf-traces now constitute leaf-gaps. The vascular tissue of this stage may be described as a "siphonostele with leaf-gaps." In describing the stele of the Marattiaceæ, the author confirmed and extended Miss Shove's statement (*Annals Bot.*, 1900) as to the internal position of the protophlœm.

On the anatomy of *Todea*, with an account of the geological history of the Osmundaceæ, by A. C. Seward, F.R.S., and Miss S. O. Ford. In this paper the authors dealt with the anatomy of the stem of *Todea barbara*, which in the main agrees with that of *Osmunda regalis*, as described by Zanetti (*Bot. Zeitung*, 1895). The paper included an account of the origin of the leaf-traces, the anatomy of the "seedling" plants and a summary of the geological history of the Osmundaceæ.

Remarks upon the nature of the stele of *Equisetum*, by J. T. Gwynne-Vaughan. The vascular bundles of *Equisetum* are usually compared with those of a monostelic phanerogam, both in structural detail and with regard to their course into the leaf. Observations made upon the stems of *E. Telmateja*, &c., show that this comparison cannot be satisfactorily maintained.

The xylem of the so-called vascular bundle of *Equisetum* was described as consisting of three strands, two of which are lateral and cauline, while the median, or carinal, strand is common to both stem and leaf. The fact that only a small portion passes out as a leaf-trace, and not the bundle as a whole, constitutes an essential point of difference between it and the bundle of a phanerogam. Potonié has established a comparison between the secondary vascular tissues of the *Calamariae* and the *Sphenophyllaceae* by mentally doing away with the central mass of primary xylem that exists in the latter. By inverting this procedure, and considering it possible that the ancestors of the equisetums may have possessed a xylem that extended to the centre of the stem, one is led to derive their structure, as it exists at present, from the modification of a stele with a solid central mass of centripetal xylem, such as that of *Sphenophyllum*, or of certain Lepidodendreæ.

It is suggested that the lateral xylem strands in the vascular bundles of the existing equisetums may perhaps be taken to represent the last remnants of a primitive central mass, and that this would be entirely in agreement with their apparently centripetal development, and in particular with their cauline course.

Fossil Plants, &c.—On a primitive type of structure in Calamites, by D. H. Scott, F.R.S. Palæontological research has afforded evidence that the horsetails and lycopods had a common origin. The class sphenophyllales, restricted, so far as we know, to the Palæozoic epoch, combines in an unmistakable manner the characters of equisetales and lycopodiales, while at the same time presenting peculiar features of its own.

The synthetic nature of the sphenophyllales, indicated clearly enough in the type-genus *Sphenophyllum* itself, comes out still more obviously in the new genus *Cheirostrobus*. So far nothing has been found to bridge the gulf which separates the anatomy of the Calamarieæ (Palæozoic equisetales) from that of the sphenophyllales or the lycopods.

Dr. D. H. Scott gave an account of a calamite from the Calciferous Sandstone of Burntisland, in which each vascular bundle is characterised by the possession of a distinct arc of centripetal wood on the side towards the pith. The carinal canals are present, as in an ordinary calamite, and contain, as usual, the remains of the disorganised protoxylem. They do not, however, as in other equisetales, form the inner limit of the wood, but xylem of a considerable thickness, and consisting of typical tracheides, extends into the pith on the inner side of the canal, which is thus completely enclosed by the wood. That the organ was a stem, and not a root, is proved, not only by the presence of the carinal canals, but by the occurrence of nodes, at which the outgoing leaf-traces are clearly seen. This appears to be the first case of centripetal wood observed in a calamarian stem, and thus serves to furnish a new link between the Palæozoic equisetales and the sphenophyllales, and through them with the lycopods.

Provisionally, the new stem may bear the name of *Calamites pettycurensis*, from the locality where it occurs.

In a paper on the past history of the Yew in Great Britain and Ireland, Prof. Conwentz (Danzig) gave an account of his researches into the causes of the disappearance of this species from nearly all parts of middle and northern Europe. He expressed the view that the genus *Taxus*, which has now passed its zenith, is of no great geological antiquity; most of the Tertiary fossils described as species of yew were found to have been incorrectly determined. Prof. Conwentz dealt with a mass of evidence which he had examined, proving that the yew had been formerly widely distributed in regions where it has ceased to exist. The evidence was derived from the microscopical examination of subfossil wood, the occurrence of prehistoric and historic antiquities preserved in the British Museum, in the Science and Arts Museum in Dublin and elsewhere, and from the abundance of place-names in England, Scotland and Ireland which owed their origin to the former existence of yew trees.

On the distribution of certain forest trees in Scotland, as shown by the investigation of post-glacial deposits, by W. N. Niven. The author gave a summary of facts obtained from various topographical books and other sources concerning the distribution of the following trees:—Hawthorn, elder, common ash, birch, alder, hazel, oak, willow, yew and fir, all of which, with the exception of the ash, are considered natives of Scotland. The cones of the silver fir have been dug out of the peat in Orkney, but this tree is not now indigenous to Scotland. Several shrubs, including the juniper and raspberry, as well as many flowering plants, have also been discovered. Mr. Niven pointed out that there are few parts of Scotland, however treeless at the present day, that were not in remote, and even in comparatively recent, times covered with woodlands. This is also shown by the place-names.

The evidence, which is obtained by the examination of the various post-glacial deposits, indicates in a very clear manner that the trees recorded should be considered truly indigenous to Scotland.

Prof. Potonié, of Berlin, read a paper on "Die Silur- und Culm-Flora des Harzes." On certain points in the structure of the seeds *Aethiotesta*, Brongn. and *Stephanospermum*, Brongn., by Prof. F. W. Oliver. The author gave some account of the anatomy of the fossil gymnosperm seed named by Brongniart *Stephanospermum akenioides*, and of another seed nearly allied to the foregoing which he provisionally recognised as *Aethiotesta subglobosa*, Brongn. Attention was drawn to the mantle of tracheal tissue which invests the nucellus in both cases. The possible physiological significance of this tissue was considered, and some suggestions were offered as to the conditions which led to the evolution of the seed in this group. The author expressed the opinion that there was considerable probability that the seed habit was at its origin a xerophilous adaptation.

The structure and origin of jet, by A. C. Seward, F.R.S. The author has recently examined several sections of Yorkshire jet in the British Museum, which he believes demonstrate the origin of this substance from the alteration of coniferous wood and, in part at least, of wood of the Araucarian type. Sections cut from specimens, which consist in part of petrified wood and in part of jet, enable us to trace a gradual passage from well preserved Araucarian wood to pure jet, which affords little or no evidence of its ligneous origin. The conclusion arrived at is that the Whitby jet owes its origin to the alteration of coniferous wood. The fact that jet frequently occurs in the form of flattened blocks of wood in all probability admits of the natural explanation that the jet has been derived from the wood, the form of which it has assumed, and not that the jet was formed elsewhere and permeated the tissues of the wood as a fluid bitumen.

Mr. E. A. N. Arber described a number of specimens contained in the Clarke collection of fossil plants from New South Wales. The collection, which is now in the Geological Museum, Cambridge, is noteworthy as being one of the earliest (1839-44) obtained from the continent of Australia.

A chapter of plant evolution, by A. C. Seward, F.R.S. The author described the chief features in the floras ranging from the Rhætic to the Wealden; he drew attention to the dominant types which characterised this long succession of stages in the earth's history and discussed the progress of plant-evolution from the close of the Triassic period to the appearance of angiosperms in rocks of Lower Cretaceous age.

Morphology.—Cuticular structure of *Euphorbia Abdelkuri*, by Prof. Bayley Balfour, F.R.S. *Euphorbia Abdelkuri* is an interesting succulent plant which has been brought home from a small island in the vicinity of Sokotra by the Ogilvie-Forbes Expedition. The outer surface of the plant in the fresh condition appears to be covered with a crust which readily cracks off, and on examination this is found to consist of a number of prisms. At first sight these may be taken for some form of mineral incrustation, but they are not of this nature, being formed by the cuticle of the epidermal cells. This does not form an uninterrupted layer over the epidermis, but the cuticle of each cell is separable from that of the adjacent ones, and the prisms are merely blocks of cuticle, each one belonging to a single cell. This is a construction different from that which is ordinarily met with in plants with a thick cuticular layer.

Miss A. M. Clark described abnormal secondary thickening in *Kendrickia Walkeri*, a tropical epiphytic climbing shrub. The anatomy of the young stem is typical of the family Melastomaceæ. At an early stage numerous small patches and several large wedge-shaped areas of thin-walled unlignified wood-parenchyma are cut off from the inner side of the completely circular cambium ring. Tylosis is of frequent occurrence, and the tylosed cells may develop into sclerotic cells inside the vessels and racheids. At a later stage, the unlignified wood-parenchyma cells at the central margin of the wedge area take upon themselves new growth accompanied by cell-division. The product of this new growth proceeds to split the axial woody ring into a number of portions, with subsequent destruction of the identity of the wood elements. Later, the quiescent cambium lying between the original internal phloëm and the axial woody ring takes upon itself new growth, and proceeds to lay down xylem on the one side and phloëm on the other.

The histology of the sieve tubes of *Pinus*, by A. W. Hill.—The author's researches have proved that the results obtained by Russow are, in the main, correct; the mature sieve-plate is traversed by groups of callus rods, which are interrupted at the middle lamella by median nodules, and each callus rod contains from three to seven striæ—or spots if examined in surface-view—which are strings of slime. The youngest sieve-plates or pit-closing membranes, which could be examined, showed "connecting threads" like those in ordinary tissue; but in the so-called "boundary cells"—*i.e.* the youngest thick-walled sieve-tubes—a change takes place, namely, the appearance of the callus. Callus first appears on one surface of the sieve-plate, at the places where the groups of "connecting threads" occur, and it gradually spreads as a rod along a group of the threads to the middle lamella; a similar change then takes place on the other side of the lamella. The lamella itself, however, is not converted into callus, but a refractive median nodule appears separating the two portions of the callus rod. Accompanying this change the protoplasmic threads become converted into slime strings. The changes described were considered by the author to be due to the action of ferments.

Dr. Lotsy dealt with examples of heterogenesis in conifers. The expressions heterogenesis (Korschinsky, "Flora," 1901), mutation and spontaneous variation have practically the same meaning, and are applied to phenomena which illustrate one method by which new species may be formed. The author exhibited a specimen of *Capsella Heegeri*, given to him by Count Solms-Laubach, who recently described this species as a new form which appeared to have arisen suddenly from *Capsella bursa pastoris* (*Bot. Zeitung*, 1900). Reference was made to Hugo de Vries' important publication ("Mutationstheorie") in which several new species are described as having been formed as the result of sudden variations, which were manifested during certain periods of spontaneous variation. Dr. Lotsy drew attention to two genera of conifers—*Cupressus* and *Thuya*—which he described as passing through a period of spontaneous variation. Among a large number of seedlings of *Cupressus Lawsoniana* two plants were raised which exhibited marked differences—*C. Lawsoniana Wisseti* and *C. Lawsoniana lycopodioides*, forms which would undoubtedly be described as new species if their common origin were not known. *Thuya occidentalis Spaethi* was also described as a new form which had been produced as the result of sudden variation.

Mr. John Paterson read a paper in which he dealt with the biology and anatomy of *Stellaria holostea* and allied species. He gave a brief comparative account of the anatomical structure in *Stellaria graminea*, *S. media*, *S. glauca* and other Caryophyllaceæ.

Mr. W. C. Worsdell submitted a paper on the morphology of the ovule; an historical sketch. The same author communicated a note on the morphology of the "flowers" of *Cephalotaxus*, containing an account of original observations on proliferated inflorescences and flowers, which afforded evidence in support of the foliolar theory of the ovule as put forward by Celakovsky.

Physiology, &c.—Prof. Kny (Berlin) read a paper on Correlation in the growth of roots and shoots, in which he dealt with certain criticisms directed by Heering (*Pringsheim's Jahrb.*, 1896) against a communication on the same subject published by the author in 1894 (*Annals Bot.*). In the first paper the final results, and not a detailed account of the experiments, were published. Prof. Kny stated that his recent experiments had shown that in cuttings of *Ampelopsis quinquefolia*, as in those of certain species of *Salix*, the continual removal of the young shoots was soon followed by a less vigorous development of roots, and *vice versâ*. In *Salix* the retarding influence is first apparent in the roots, while in *Ampelopsis* the shoots were found to be the more sensitive.

Dr. F. F. Blackman and Miss Matthaei contributed a paper on natural surgery in leaves (*Annals Bot.*, 1901). If patches of leaf-tissue be killed in any way, the leaf reacts by forming an "absciss"-line round the injured spots at a little distance off in the healthy tissue. Separation soon takes place at this "absciss" line, so that the dead tissue which might be a source of danger is cut right round and drops out of the leaf. The same authors gave a paper on the relation between CO_2 production and vitality. This communication chiefly dealt with the effect of loss of water upon the CO_2-production in leaves. Even a small loss of water causes a very marked increase of the CO_2, and this effect continues until the water is restored

On the absorption of ammonia from polluted sea-water by *Ulva latissima*, by Prof. Letts and John Hawthorne. In a previous research (*Proc.* Roy. Soc. Edin. 1901) it was shown that the occurrence of this sea-weed in quantity in a given locality is associated with the pollution of the sea-water by sewage, the evidence being of three kinds: (1) The high proportion of nitrogen contained in the tissues of the *Ulva*; (2) an examination of certain localities in which the sea-weed occurs in abundance, and of others from which it is virtually absent; and (3) experiments on the assimilation of nitrogenous compounds by the growing *Ulva* from sea-water artificially polluted.

The following conclusions were drawn from recent experiments:—(1) The absorption of ammonia by the sea-weed is very rapid, and with the mixtures used practically all the ammonia was absorbed in five hours (with one exception, when 75 per cent. was lost). (2) The amount absorbed is greatest during the first hour of contact, and then rapidly falls off. (3) Although the concentration of the ammonia exercises some effect on the proportion absorbed, it is by no means so considerable as might have been expected. (4) The sea-weed absorbs ammonia both in daylight and in darkness, but the proportion in the latter case is rather less than in the former. (5) The effects of an increased area of the sea-weed on the proportion of ammonia absorbed are not so great as might have been expected. These results may be of practical importance in those districts where a serious nuisance results from the decay of large quantities of the *Ulva*, which have been washed ashore, or have accumulated in shallow water.

The diameter increment of trees, by A. W. Borthwick. There are two methods by which the rate of growth in thickness or diameter increment of trees can be ascertained. One of these methods is to measure annually or at certain intervals the diameter or circumference by means of tree callipers or a tape. The only other method of investigating the diameter increment on standing trees is by means of a very useful instrument known as Pressler's increment-borer. Mr. Borthwick stated that through the kindness of Prof. Bayley Balfour he had recently had the opportunity of testing whether the increment-borer would yield the same results as those furnished by the tape. A comparison of results showed a close agreement between the two methods.

Dr. R. J. Anderson described an apparatus for studying the rate of flow of solutions in plant stems, and gave a preliminary account of experiments on which he is at present engaged.

On the strength and resistance to pressure of certain seeds and fruits, by Prof. G. F. Scott Elliot. The author described experiments which he had made in order to determine the amount of weight which seeds can endure without breaking. The experiments were generally conducted by means of a spring balance weighing up to 50 lbs.; seeds and fruits which withstood a pressure of 50 lbs. were tested with a Wicksteed's single-lever vertical testing machine. The paper dealt also with the relation between the resisting power and the shape and structure of seeds. Attention was called to various peculiarities of fruits and seeds which serve as important aids to their resisting power.

Forestry.—Mr. Samuel Margerison communicated a paper on the transport of British timber. He drew attention to the fact that imported fir sold at a less price than that at which British fir can be delivered, and urged the desirability of bearing in mind the question of transport in the scientific development of our forests.

Mr. G. P. Hughes gave an account of Government plantings in the Isle of Man.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Mr. David B. Monro, Provost of Oriel, succeeds the Rev. Dr. Fowler, President of Corpus Christi College, as Vice-Chancellor.

CAMBRIDGE.—The moderators for the mathematical tripos, 1902, are Mr. W. Burnside, F.R.S., Pembroke, and Mr. J. Greaves, Christ's. The examiners are Mr. J. G. Leathem, St. John's, and Mr. J. H. Grace, Peterhouse.

The outgoing Vice-Chancellor, Mr. Chawner, Master of Emmanuel College, in his valedictory address, stated that the amount received for the Benefaction Fund was more than 66,000*l*. This, though it falls short of what is required even for the pressing needs of the University, has made it possible to enter into contracts for the Botany School, and a substantial portion of the Medical School buildings. Dr. Lawrence Humphry has been appointed assessor to the regius professor of physic, and Sir R. S. Ball an elector to the Isaac Newton scholarships. Prof. W. R. Sorley has been elected to a professorial fellowship at King's College. Prof. Somerville has informed the Vice-Chancellor that, having accepted a post in His Majesty's Board of Agriculture, he will resign the chair of agriculture at the end of the present term. Mr. K. Lucas, of Trinity College, has been nominated to occupy the University table in the Marine Biological Laboratory at Plymouth. Mr. J. H. Jeans, second wrangler 1898, Smith's prizeman 1901, and Mr. H. A. Wilson, research student in physics 1899, have been elected to fellowships at Trinity College.

IN delivering the opening address of the winter session of St. Andrews University last week, Principal Donaldson spoke on the subject of Mr. Carnegie's recent gift and the relation of the universities to the trade and commerce of the country. With reference to the first part of his subject Principal Donaldson said that the gift of Mr. Carnegie rendered it possible for every Scotsman to obtain a university education if he was capable of it; its second purpose was to increase the usefulness and influence of the Scottish universities by furnishing them with lectureships, laboratories, scholarships of research, and every form of equipment that could enable them to do their work most effectively. It was impossible to estimate the value of this part of the gift, of the possibilities which it created, and of the good that it would do to the whole community. It would bring all the various departments of study up to a high level, and especially it would promote in the highest degree original inquiry and investigation. For want of means they had fallen behind in this department, but the difficulties were now removed. Every student who had the ability to conduct original research would have his opportunity, and they might expect Scotland to take a foremost place in those scientific discoveries and inventions which were the prominent feature of our age.

SPEAKING on Saturday last to the Medical Faculty of University College, Liverpool, Prof. Oliver Lodge, F.R.S., Principal of Birmingham University, said a year ago he did not expect to find the full University ideal so prominently to the front; but any hesitation that might have been felt at urging it too hastily or inopportunely had been removed by the resolution of their council—their college council and likewise their city council—that a University for Liverpool was a necessity, and that any step towards furthering of that object would be welcome. The multiplication of municipalities, said Dr. Lodge, was wholly good. Why should the multiplication of Universities be considered bad? Let every city become a University when it was worthy, but it must make itself worthy first. Proceeding, he said that one of the functions of a University was the increase or improvement of knowledge, what was called "research." The ancient formula of the Royal Society stated that it existed "for the improvement of natural knowledge." He commended to their notice this word "improvement." Their primary aim should be improvement. The guardians of knowledge must be improvers of it, else it began to decay and to be lost. A University was the corporate repository of learning, not of ancient learning only, but of modern learning too; the most recently discovered fact of science there found its natural guardians, and there it was that new facts should be born. He commended this notion of "improvement of knowledge" to students, to every class of student. An atmosphere of constant effort towards the improvement of knowledge, with the accompanying stimulus of potential discovery; this was the atmosphere that should enfold every earnest student who entered the portal of a modern University.

THE new department of pathology of the University of Oxford was formally inaugurated on Saturday last. The building, which has been erected at the cost of about 10,000*l.* (5000*l.* of which was the gift of Dr. Ewan Fraser, of Balliol College), occupies a site at the back of the University Museum. It is rectangular in shape, measuring 75 feet by 65 feet, and consists of a basement and two storeys, the rooms being grouped round a central vestibule. Amongst the latter are a lecture room, a museum, laboratories for the teaching of morbid histology and of bacteriology, research rooms for work in experimental pathology and in chemical pathology, and various store rooms, attendant's work room, workshop, and cold-room are also provided. Sir William Church, president of the Royal College of Physicians, in delivering the opening address, said that the eightieth anniversary of the birthday of the Nestor of pathological research, Prof. Virchow, being that day celebrated. Oxford could not in a more worthy way pay its homage to the veteran man of science. Just at the time that their museum was being erected, Prof. Virchow gave to the world his memorable work, "Die Cellular Pathologie," which placed pathology on a new foundation and taught them to regard pathological processes as the perversion of physiological ones, influenced by various disturbing agencies. Pathology could not be studied without physiology, neither could physiology in its completeness be carried on without pathology, and more especially had this become manifest since they had been acquainted with the part played by micro-organisms in the universe, and the influence they had on living structures. A knowledge of both physiology and pathology was indispensable for those who would practise medicine; but to regard pathology as a mere adjunct to medicine was to take a narrow and erroneous view of the processes of nature. As a physician he could not but regard with extreme satisfaction the addition which had been made to the opportunities afforded to their medical graduates for the acquisition of scientific knowledge, but he was far from looking upon the technical work which would be done in direct connection with medicine as the only, or, indeed, the main, advantage which would accrue from it. Pathology at the present time was, above all others, that section of medical science which offered the widest promise of progress, and by the original research which under the guidance of the able head of their pathological department would there be carried on, he trusted that real advances in knowledge might be made which both directly and indirectly might benefit mankind, and that in pathology, as in the other departments of science, Oxford might hold an honourable record

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 7.—M. Bouquet de la Grye in the chair.—On the extension of a formula of Euler and on the calculation of the principal moments of inertia of a system of material points, by M. K. Bohlin.—General properties of couples of kinematic elements, by M. G. Kœnigs.—The action of urethane on pyruvic acid, by M. L. J. Simon. Pyruvic acid combines directly with urethane without the use of any condensing agent, the compound $CH_3.C(NH.CO_2C_2H_5)_2CO.OH$ being formed. The ethyl ester of this substance can also be obtained by condensation of ethyl pyruvate with urethane, but in this case a little hydrochloric acid is necessary to assist the reaction Boiling with dilute acid readily regenerates the pyruvic acid.—On monobromomalonic dialdehyde, by M. R. Lespieau. This substance is formed by the action of bromine in bright sunlight upon the substance $CHBr:CBr.CH_2OCH_3$. Owing to its forming a potassium salt it was at first taken for an acid, but its aldehydic nature is clearly established by its reactions with Schiff's reagent, and the formation of phenylbromopyrazol with phenylhydrazine.—On the reducing properties of certain nitric esters, by MM. Leo Vignon and F. Gerin. The nitric esters derived from methyl and ethyl alcohols, glycol and glycerol do not reduce an alkaline copper solution. Tetranitroerythritol possesses faintly reducing properties whilst a strong reduction is produced by the nitrates of dulcitol and mannitol.—Experimental researches on the excitability of the spinal marrow, by M. Alex. N. Vitznou. It is shown that, contrary to the results of previous experimenters, the grey matter of the spinal column can be excited by electric currents, and that there is a clear difference between the reactions which are produced as a consequence of the stimulation of the antero-lateral cords and those resulting from the stimulation of the grey matter, the latter producing generally tetanic movements. The grey substance can also be excited by simply mechanical means, if care be taken that there is as little loss of blood as possible during the preliminary operation.—The influence of spermotoxin upon reproduction, by Mlle. C. de Leslie. If some spermotoxic serum furnished by a guinea-pig is injected into a white mouse, the latter loses its power of reproduction, the sterility being maintained for from sixteen to twenty days.—On the liberoligneous elements of ferns, by MM. C. Eg. Bertrand and E. Cornaille.—Double flowers and parasitism, by M. Marin Molliard. In two cases (*Primula officinalis* and *Scabiosa Columbaria*) in which a tendency to form double flowers was observed, it was found that the roots were attacked by parasitic fungi, and it appears very probable that it is to these parasites that the changes in the flowers must be attributed. The author points out that these facts may have important applications in practical horticulture.—An experimental contribution to the study of the physical signs of intelligence, by M. N. Vaschide and Mlle. M. Pelletier. As the result of measurements made on more than 300 children it was found that the cephalic development of the intelligent subjects was different from an anthropological point of view from the unintelligent subjects. The most marked difference is in the magnitude of the auriculo-bregmatic measurement.

CONTENTS.

THURSDAY, OCTOBER 24, 1901.

LIFE BY THE SEA-SHORE.

Life by the Sea-shore: an Introduction to Natural History. By Marion Newbigin, D.Sc., &c. Pp. viii + 344. (London: Swan Sonnenschein and Co., Ltd., 1901.) Price 3*s.* 6*d.* net.

MANY of the people who now live on the coast, or of the constantly increasing numbers who periodically migrate for a few weeks to the sea-side, must have often felt the need of just such a book as the one before us. It is suited to the junior student or the amateur who as yet knows little or nothing of marine life; it is moderate in size and price, and contains a wonderful amount of information; it is almost as refreshing as a dip in the briny itself, and in the treatment of its subject-matter it reminds us of Charles Kingsley's "Glaucus" and of Philip Gosse's "Year at the Shore," and other charming works of a former generation. We in Britain are a maritime people, we owe much to the sea, and we boast on all appropriate occasions of our connection with it. Surely, then, we ought all of us to have some elementary knowledge of oceanography—of our seas and their ways and their inhabitants. British naturalists in the past have done much to enrich marine zoology by splendid monographs, such as those of the Ray Society and some of Van Voorst's series; but the public at the sea-side cannot be expected to read monographs—or to understand them if they did—and the volumes of Gosse are out of print, and moreover are somewhat antiquated both in nomenclature and science.

The present little book by Dr. Marion Newbigin is quite up to date, and although scientifically accurate and sound is so delightfully simple that it can be read and comprehended by anyone at the sea-side who can collect common shore animals and compare them with the printed pages. It is food for babes compared with the monographs, but is at the same time sufficiently nourishing and stimulating to lead to the healthy development of sturdy young marine zoologists. Judging from the results I have had with some average school-girls of fifteen to eighteen upon whom it has been tried during the last few weeks, I should expect that this book will give rise to many delightful collecting expeditions, and after-hours full of intellectual pleasure when observing and identifying the specimens and reading up and verifying their characteristics. It is satisfactory, by the way, to see that Miss Newbigin insists upon the educational value of a certain amount of collecting and of species work—"and the identifying of species, though now sadly out of fashion, is an occupation which may yield one of the subtlest of pleasures." "So much of the present-day academical teaching seems to have [a certain] result, that I cannot but urge anyone beginning open-air studies to find some time for species work, and for this habits of patient and minute observation are essential," &c. (p. 25).

Our author is already known to zoologists from her papers on the pigments of Crustacea and other animals and her little book on "Colour in Nature." The present book, she tells us, is based upon a course of lectures—given presumably to Edinburgh students, as most of the animals dealt with, or chosen as types, are common east coast forms, and as a result one occasionally comes upon a remark that does not apply to other parts of our sea.

After a couple of introductory chapters on the conditions of shore life and the general characteristics of shore animals, such as shells, burrowing, weapons, partnerships, masking, larval characters, classification, hints as to methods, and so on, Chapter iii. starts with sponges and goes on to zoophytes. Then sea-anemones, worms, echinoderms, crustacea, molluscs, fishes and ascidians occupy the next twelve chapters, after which is a final section on the distribution and relations of shore animals, a list of works of reference and a double index. On the whole, perhaps the section on the higher Crustacea is the most full and satisfactory. The crabs seem especially well done, and also the polychætes. More space than the passing reference on p. 27 should have been given to the Protozoa. It is useless to pretend that the subject-matter of this book can be worked through without the microscope, and if that instrument is required for the triradiate spicules of the calcareous sponge, why should it not be applied to show us *Noctiluca* and *Ceratium* and *Rotalia* and *Folliculina* or some other equally common and important shore Protozoa? A short section on a few of the more abundant diatoms also would be justified by their great importance in connection with the food of animals in the sea, and ultimately of man.

One would rather not make any critical remarks—but few are needed—and if certain points are now noted which may seem to detract to some extent from the value of the book, they are not put forward in any fault-finding spirit, but are to be regarded rather as suggestions which may be of use to the author when a second edition is called for. There is a certain want of proportion in the amount of space allotted to different groups. For example, we find more than twenty pages, and a dozen figures, on the hydroid zoophytes, and less than twenty lines (no figures) on the Polyzoa, which are so constantly associated with the hydroids in shore pools and on seaweeds such as *Fucus* and *Laminaria.* It is difficult to see any reason for this and a few other cases of arbitrary selection. The two groups occur together, the Polyzoa are usually the more abundant and striking, the same methods of collecting and examining apply—the pocket lens will show a certain amount of the structure of the colony in each case, but a microscope is really necessary for both. And as to the æsthetic pleasures derived from beauty and charm of movement, I find that the commonest of shore Polyzoa—such as *Flustrella hispida*, found all round our coasts, in profusion, on *Fucus*—alive in a watch-glass of sea-water under even a low power of the microscope, protruding and retracting its crown of ciliated tentacles, is one of the most fascinating objects that can be shown to, or found by, the young naturalist on the sea-shore, and one of the most easily obtainable from which to demonstrate ciliary action and to give as an example of an animal collecting food by causing currents in the water.

I have alluded to the inadequate treatment of Protozoa. A more serious omission even is that of the Copepoda, a group of great importance amongst marine animals on account both of its numerical strength and of the activity and utility of its members. It is true that very many of these are obtained from the surface of the sea and not strictly from the shore, but that same remark applies equally to the medusoids discussed and figured in Chapter iii., and it would be difficult to catch the medusoids without seeing Copepoda also. But there are also plenty of shore-haunting copepods to be obtained very easily with a muslin hand-net in pools, or from sand and mud at low tide, and under stones. A small boy of six has just brought me a cup full of bright red ones (*Harpacticus fulvus*) which he caught himself with a sixpenny hand-net along the edge of the sea and in pools, where they are quite visible to the eye. He wanted to know what they were and how they jumped, and his little sister of two-and-a-half added the important question, "Why are they so red?" If Miss Newbigin would answer these questions—and no one is more competent than she to deal with the last one—it would help not only the children, but their seniors. *Harpacticus* is sometimes very abundant in pools far up the shore, where their red bodies are quite conspicuous on the green *Enteromorpha*, and they are eaten with avidity by young blennies, sticklebacks and other little shore fishes. "*Why are they so red?*"[1]

The "keys for identification" and other similar tables of characters at the ends of chapters are of doubtful utility. They are, of course, incomplete; they only deal with a few selected genera and species in each section, and yet from their form they give the deceptive impression of a complete classification; they lead to a good deal of repetition and give little information beyond what is in the text—a considerable saving of space would be effected by their removal. What is the difference between "legs very slender and long" given as a character of *Phoxichilidium*, and "legs very long and slender" as a character of *Nymphon* in the table on p. 224?

Dissection of the types chosen and details of internal structure have, probably quite wisely, been avoided; but under those circumstances some statements in the book, such as that "the heart is in front of the gill" (p. 248) given as a character of the opisthobranchs, will probably be found meaningless to readers without further knowledge than the book gives. Even one simple anatomical diagram of the type form of each group would have been a useful addition.

There are, of course, other points of detail in connection with which alterations might be suggested. *Asterina gibbosa*, very common in shore pools amongst *Corallina* on some parts of the coast, might be added to the star-fishes discussed. The presence of thread-cells in the cerata of *Eolis* is an interesting point worthy of mention. *Trochus zizyphinus* (p. 236) is not merely an inhabitant of deep water, but is common, alive, between tide-marks on some of our shores. On the whole the figures are good, but *Alcyonium* (p. 16), *Polycarpa* (p. 295) and *Pleurobrachia* (p. 330) are not satisfactory.

The style of the book is easy and pleasing—lively even in places, as on p. 277, where the author describes how she first made acquaintance with the grace and beauty of the living *Lima hians* when released from its woven nest of shells and weeds. In conclusion, it is a pleasure to cordially recommend "Life by the Sea-shore" as a charming and useful holiday companion which will not only give much information, but will also serve as a good introduction to one of the most fascinating branches of modern science.

W. A. Herdman.

[1] Obviously, there are two kinds of answer—the one in terms of lipochromes and the other in terms of natural selection.

SCIENTIFIC TOPOGRAPHY.

Recherches sur les instruments, les méthodes et le dessin Topographiques. By Colonel A. Laussedat. Tome ii. Part i. Pp. 198. (Paris: Gauthier-Villars et Fils, 1901.)

IN the first part of the second volume of his exhaustive treatise on topography, Colonel Laussedat treats of "iconométrie" and "métrophotographie"—two branches of the art which are but little studied in British military schools. He commences by tracing the evolution of the photo-theodolite from the primitive forms of the camera obscura and the camera lucida; and not the least instructive part of this volume is to be found in the careful analysis of those principles of perspective which are the governing principles of all methods of reducing a field of observation to its horizontal plan, whether for the purpose of topography or of plan drawing. He shows that the camera lucida is an instrument which (in France at any rate) has proved of immense value in the hands of the military engineer. Some excellent examples are given by Colonel Laussedat of the practical use that has been made of this instrument in the construction of accurate geometrical views of fortifications, with the object of obtaining precise plans of the same, on the principle which was first advocated by Beautemps-Beaupré, and which is fully explained by the author. It is curious that an English invention (it was invented in 1804 by Wollaston) should have been applied to so much greater practical purpose in France than it ever has been in England.

From camera lucida drawings of the elevation of a line of fortifications, or of buildings taken from two or more points of view, French engineers have found it possible to construct accurate plans of the same fortifications on precisely the same principles which now lead to the definition of topography from photographs. With this instrument, combined with a telescopic enlargement of the field of view, the defenders of Paris during the last memorable siege were able to construct a fairly accurate panorama of the German advanced positions around the city, to note the daily and hourly changes in those positions, and to keep the military authorities perpetually supplied with most important information which would otherwise have been impossible to attain. In his concluding chapter Colonel Laussedat renders a well-deserved tribute of recognition to those many assistants (astronomers, doctors, engineers, artists and architects) who all brought the necessary technical artistic skill to his assistance and maintained that remarkable record. In England the camera lucida is still recognised as an important aid to the illustration of geological phenomena. But its capabilities as a military instrument have been hardly recognised.

From the camera lucida to the photo-theodolite is a natural process of evolution, and the best half of the volume is devoted to its illustration. The application of photography to surveying has already been well tested in many European fields, as well as in America. Some tentative efforts are now being made to introduce the photo-theodolite to India, but the results are hardly mature enough to justify any opinion as to their success. In France photo-topography has been chiefly applied to the field of that which we should term in England "revenue" or "cadastral" survey; and in Canada (a fact which is not recognised by Colonel Laussedat) a still wider opening has been afforded by the Geological Survey, which is practically a small scale topographical survey leading to the first general map of the country. There are, at any rate, records sufficient to enable us to bring the test of actual experience in other countries than France to bear on Colonel Laussedat's estimate of the capabilities of the system. That estimate appears to be absolutely favourable, but it must be contended that the illustrations which support Colonel Laussedat's opinion are not in themselves comprehensive enough to justify the conclusions at which he arrives, which would apparently include all classes of reconnaissance, or survey, in all conditions of ground as suitable for its application.

An official examination into the results of a photo-theodolite survey was conducted in Paris as long ago as the year 1859, and the report of the commissioners nominated by the Academy of Sciences was so favourable that in 1863 a "photo-topographic brigade" was formed, under the direction of Laussedat, which executed surveys on comparatively large scales (from 1/1000 to 1/20000), and which lasted for a period of eight years. The brigade was broken up in 1871, and whilst Colonel Laussedat refrains from commenting on the reasons for its suppression, he clearly indicates that it was for no reason which implied technical failure.

Various modifications of the original system are discussed or recommended, and one or two excellent illustrations of the resulting surveys are given at the end of the book. But it must be noted that the field of survey to which this process has been applied in France is after all but local, and the scale of mapping is comparatively large. For instance, we find in Plate xiii. a reproduction of about 15 square miles of country, originally surveyed on a scale approximating to 12 inches per mile (reduced to one-fourth in reproduction), to which the following details are appended. The survey was completed in ten days in the field, supplemented by two and a half months of subsequent work in the drawing office (bureau). It involved the use of fifty-two photographs, which were taken at thirty-one stations. Of these stations eighteen were stations of triangulation, and the rest "supplementary." The map itself is fully contoured and apparently quite up to the standard, in detail, of maps on a similar scale executed by the English Ordnance Survey. The time (and consequently the expense) involved in its production will of course compare favourably with that of any other known system of surveying; but it would be rash to infer therefrom that photo-topography is under all conditions either a cheap or a rapid method of surveying. In Canada good work has been done by this process on the smaller scales of one inch or two inches per mile, and the system generally is well established. But Canadian surveyors are not prepared to advocate it in entire supersession of the more widely known system of plane table topography based on triangulation, maintaining that its advantages are confined to comparatively restricted conditions of surface conformation. Thirty-one stations of observation in fifteen square miles of country (giving an average of two "fixings" per square mile) may under certain conditions be sufficient to enable a surveyor to see into the topographical detail of ridge and furrow, plain and gully, that the country presents, and result in a creditable map. But in a vast proportion of the broken and rugged districts presented by the varied physiography of Asia, Africa, or America two stations per mile would certainly not be sufficient, and the accumulation of photographs would rapidly become an unwieldy burden. When we consider the requirements of geographical surveys on yet smaller scales (say 1/500000) it is impossible to concede that the recognised systems of rapid plane tabling in experienced hands, which result in daily outturns which may be reckoned in scores of square miles of finished mapping (no "bureau" work is required by a really well-trained topographer), can be surpassed in rapidity by any more complicated process which has yet been invented.

Possibly the discussion of the application of photography to this most important field of geographical survey may be reserved for a future volume, although it might certainly have been usefully included in the present one. The author is at any rate on perfectly sound ground when he recommends every explorer who makes use of photography for illustrative purposes to fix the position of his views and the direction (or azimuth) of them with careful exactness on his route map; with the assurance that in scientific hands they will prove of immense value in elucidating the topography of the country which they illustrate if they are thus registered.

There is no work in the English language equal to that of Colonel Laussedat as a comprehensive and up-to-date review of the history and development of topography; in the value of its scientific deductions and illustrations; or in the interest which is sustained by the literary skill exhibited. It should find a place in every library of civil or military engineering institutions which professes to maintain an efficient stock of standard works for reference.

T. H. H.

EUCLID REVISED.

Euclid's Elements of Geometry. Books i.-iv., vi. and xi. By Charles Smith, M.A., and Sophie Bryant, D.Sc. Pp. viii + 460. (London: Macmillan and Co., Ltd., 1901.) Price 4*s*. 6*d*.

IF Euclid is to continue as the foundation of geometrical teaching in our schools, this work must be very warmly welcomed. The exact order of Euclid is followed, but (as the editors inform us) with no special regard to the exact words of the translation of Simson (who for a moment becomes "Simpson" in the foot-note on p. 79). There is also a complete absence of the mechanical chopping up of each proposition into separate blocks under the heads of "general enunciation," "particular enunciation," "hypothesis," "construction," "to prove," "proof," "conclusion," which in some text-books, and in the minds of many boys, has reduced the whole subject to an artificial jargon.

Mrs. Bryant, both as an expert logician and as the daughter of a fellow of Trinity College, Dublin (Rev. W. A. Willock), who had no belief in the appropriateness of Euclid's book except to "grown-up, hard-headed, thinking men," was sure to remove from the path of the young pupil as much of the essential difficulty of Euclid as could be removed consistently with the retention of the book as the basis of school instruction.

To follow the subject in detail, we notice that the editors have deliberately left out alternative proofs of the "Asses' Bridge" on the ground that Euclid's proof is found by experience to be more readily understood than any of the alternative proofs—a statement which surely cannot be well founded. What can be more simple than the proof founded on the superposition of two identical triangles? And, again, if we imagine the bisector of the vertical angle to be drawn, we have the result as a direct consequence of prop. iv. It is not to the point to object that Euclid will not allow us to imagine this bisector unless we can show how to draw it; if the bisector were drawn, the result would follow—that is proof enough. At the end of Book i. there is a large collection of worked-out theorems and problems; and we may specially notice the excellent exposition of the method of analysis and synthesis in pp. 102–106, which will greatly help the pupil who is learning this method of attacking problems. Besides these worked questions, there is a collection of 100 unworked exercises in illustration of Book i.

In Book ii. the fundamental propositions 12 and 13 are proved as an extension of the proposition of Pythagoras (47, Bk. i.) by the famous old windmill figure so familiar to us all; and, as the editors inform us, this proof is found in Lardner's Euclid, but cannot be traced further back. It is strange that the editors of our school Euclids should have overlooked this most interesting and graphic proof. Lardner's Euclid, now seldom seen, is—even compared with the best modern editions—a work of great usefulness and high merit.

There is a note at the end of Book ii. (p. 148) the substance of which is that pure geometry must be kept severely apart from all arithmetical conceptions; and this is followed (p. 150) by a still more remarkable note stating that "in all examinations" the use of + and −, of the abbreviation AB^2 for *the square on* AB, and of the abbreviation AB . BC for the rectangle AB, BC, is permitted in writing out all theorems and problems of geometry, provided that these are not given in Euclid's text.

Why such an extraordinary distinction and restriction should exist is incomprehensible to us, and remains so even after we have read the excuse put forward for it by the present editors; and after this excuse comes the statement

"the use of these symbols ought never to be allowed at any time until it is clear that AB^2 and AB . BC are used by the student simply as the shortest way of writing the square on AB and the rectangle contained by AB and BC, respectively."

Thus the divorce of all arithmetical conception—and, indeed, all quantitative conception—from geometry is advocated; and if the restriction were really carried out both by teachers and by examiners (which it is not), the teaching of the subject would be rendered much more slow and difficult than it is at present.

Book iii. ends with a very large collection of worked-out questions followed by 100 exercises, a very good feature being the association of each famous result with the name of its discoverer; and a similar remark may be made with regard to Book iv. Book v. is omitted, only the definitions required in Book vi. being given. Euclid's test of proportion—*i.e.* of the equality of the ratio A : B to the ratio C : D—is given and applied to six special cases (p. 293) under the heading "Theory of Proportion." This test is, of course, that C : D will be the same as A : B if when $mA \gtreqless nB$ we have $mC \gtreqless nD$; and we wonder whether any beginner in the world is introduced to the notion of the equality of ratios by this means. Probably without a single exception, every boy is first told that 4 : 2 is the same as 6 : 3, because 2 is contained in 4 just as often as 3 is contained in 6; and even if the one quantity were not contained an integer number of times in the other, he would be prepared to admit and understand the equality of ratios if this number was an endless decimal, provided it was the same for the two compared ratios. Euclid's test must infallibly be received by the beginner merely as the *ipse dixit* of Euclid; the beginner cannot understand its validity apart from arithmetical notions; and it seems rather grotesque to find it formally employed to prove such a trifle as "magnitudes which have the same ratio to the same magnitude must be equal." Lardner has, as usual, some excellent remarks on this criterion; but his exposition amounts to no justification that could possibly convince the mind of a beginner. Hear also the opinion of the Rev. W. A. Willock on the question ("Elementary Geometry of the Right Line and Circle," p. ix.):—

"The criterion of proportion used is that of Elrington, by *sub*multiples. This test is here adopted because it is more readily understood by young students, and also more conformable to the common notions of proportion. Moreover, it holds good, in all strictness, for commensurable magnitudes; and, as to the incommensurable, it holds equally good if the equisubmultiples taken of the first and third terms be infinitesimals. . . . The right conclusion as to the two tests is, probably, that both should be given in a treatise on elementary geometry, each having its own peculiar advantages."

At the end of Book vi. follows what may be regarded as a small encyclopædia of important results and methods—coaxal circles, harmonic ranges, poles and polars, centres of similitude, inversion, maxima and minima, &c.—an invaluable collection, excellently handled.

Book xi. calls for no detailed remarks: its accompanying illustrations are of the same high order of merit as that which characterises all the special work of the editors.

OUR BOOK SHELF.

The Life-History of British Serpents and their Local Distribution in the British Isles. By Gerald R. Leighton, M.D. Pp. xvi + 383. 8vo. Illustrated. (London: W. Blackwood and Sons, 1901.) Price 5*s*. net.

THE idea of supplying the "field-naturalists of the British Isles" with a handbook dealing with the life-history of the native snakes and their distribution is an excellent one. The existing treatises on British reptiles are either antiquated or compiled by writers insufficiently versed in the subject. It is only regrettable that Dr. Leighton, whilst engaged in the preparation of this little work, which contains much interesting matter, should not have made himself more thoroughly acquainted with what has been published on the subject, in England at least, as we notice the omission of important information which might have been obtained through reference to the volumes of the *Zoologist* and to the British Museum Catalogue of Snakes, of which he appears to be ignorant. The descriptions of the three species which make up the British ophidian fauna are inadequate, and this is all the more to be regretted since many points of structure and coloration which are subject to variation would have afforded an important topic in which to arouse the interest of the field-naturalist.

The reproduction of many of the photographs which are liberally scattered through the work leaves much to be desired, and the figures of the head-shields of the ring-snake or grass-snake and the smooth snake, as well as of the scales round the eye in the adder, are very inaccurate. True, the work is only intended for the non-scientific, who may perhaps not feel inclined to be too exacting on these points, if we bear in mind how few have the necessary training of the eye, in matters reptilian, to detect inaccuracies which would hardly be tolerated if they applied to birds or insects.

The book is made up to a great extent of letters from correspondents and of newspaper cuttings referring to distribution, size and habits, the adder's "swallowing of the young for protection" being, of course, the heading of an important chapter. All this is very useful and interesting information, and is well commented upon by the author.

It is not without surprise that we notice an attempt to restore the "small red viper," *Coluber chersea* of Linnæus, to the rank of a distinct species, under the new name of *Vipera rubra*, which is regarded by the author as "quite as distinct from the ordinary adder as a swallow is from a martin." On the other hand, Sowerby's *Coluber dunfrisiensis*, which still appears in the synonymy of the smooth snake (*Coronella austriaca*), is a distinct species, which inhabits North America and was erroneously ascribed to Scotland. In describing the common grass-snake it should have been stated that the yellow or orange collar is sometimes absent in adult specimens. It is held by most observers who have kept this snake that its food consists of nothing higher in the vertebrate scale than batrachians; but Dr. Leighton informs us that one of its most favourite meals consists of mice, and that it also feeds on water-voles and birds. The only instance known to the writer of this notice of a grass-snake containing a mouse is that of a sciagraph exhibited before a meeting of the Zoological Society of London a few years ago; but an inquiry elicited the fact that the mouse had been forcibly introduced. It is desirable that Dr. Leighton should adduce some more precise data in support of his statement.

In spite of the defects to which we have drawn attention, this little book will be of use and interest to field-naturalists, and will no doubt result in greater attention being bestowed on a somewhat neglected section of vertebrates. G. A. B.

The Feeding of Animals. By W. H. Jordan. Pp. xvii + 450. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1901). Price 5s. net.

THE author takes a wide range. Beginning with a popular account of the chemical constituents of plants and animals, the processes of digestion and nutrition, and the functions of food in the body, he then proceeds to a description of cattle foods, and to the actual results obtained by the use of food as ascertained by scientific investigations and farm practice. The book is written in a somewhat diffuse and popular style, and the different parts are of unequal merit, but it is of undoubted value. The author is not pledged to any special theories, but readily accepts every well-proved fact. He is well acquainted with the most recent German and American investigations, and has brought together a large number of very important new results, for which teachers will heartily thank him. Had the author written with greater accuracy for science students, instead of writing for the half-educated general reader, he would probably have produced a better book on the feeding of animals than has hitherto appeared in the English language.

The book is thoroughly American, and the author illustrates every part of the subject as far as possible by the investigations and practice of his own country. He is naturally bound by American conventions, and to one of these we must strongly demur. The whole of the nitrogenous substances present in any vegetable food are collectively spoken of as "protein," although, in fact, a large part of them may be amides, and in some cases nitrates. This is distinctly worse than the German plan of calling the whole group "Rohprotein," as in this case some qualification is expressed. The American nomenclature results in a confusion of language which must be abhorent to every physiological chemist. Thus our author says (p. 179): "A much larger part of the protein of roots consists of amides than is the case with the grains, the protein of the latter being correspondingly richer in albuminoids." It is surely far better to give the collective nitrogenous matters the general title of "nitrogenous substance" instead of applying to them the name of a particular body, which in some cases forms only a small part of the group. The error is all the more important as the amount of true proteids present in a food has generally a great influence upon its nutritive value.

The chapter by Mr. W. P. Wheeler on the feeding of poultry is of considerable importance, as he brings before us the results of many recent American investigations. R. W.

First Stage Building Construction. By Brysson Cunningham, B.E., Assoc.M.Inst.C.E. Pp. viii + 240. (London: W. B. Clive.) Price 2s.

THIS small volume on elementary building construction forms one of the "organised science series." It is intended for students preparing for the examinations in elementary building construction under the Board of Education. There are already several books published which cover the same course, but none, we believe, which profess to do so at the modest price of 2s., as does the volume before us. Mr. Cunningham's book does not call for much comment. The information given is of the kind required, and is well and tersely put in a practical way, but the diagrams, which are so important in a book of this kind, are in many cases very carelessly drawn, and do no credit to the book. If these are improved in a future edition, it will render the book more valuable.

Théorie Nouvelle de la Dispersion. Par M. G. Quesneville. Pp. 72. (Paris: A. Hermann, 1901.)

WE opened this book in the hope of finding an intelligent criticism of modern theories of dispersion and an attempt to substitute something better; but the author appears to be very imperfectly acquainted with them; for instance, there is no reference to Sellmeier, or to Lord Kelvin's Baltimore lectures. His criticisms are mainly directed to the writings of Cauchy. The "new theory" does not appear to include any new suggestion as to physical mechanism, or anything to repay the labour of wading through sixty pages of algebraic developments. J. D. E.

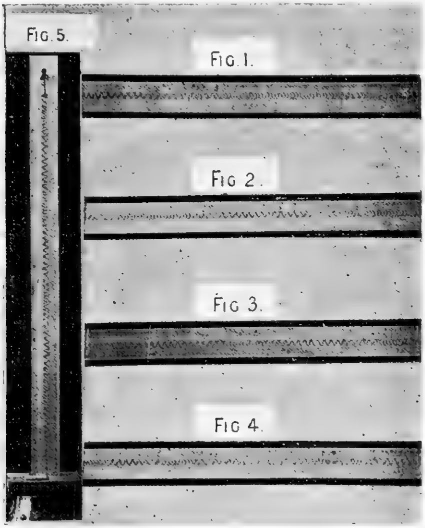
LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Simple Model for Demonstrating Beat.

THE phenomenon of beat produced by the interference of two series of waves having nearly the same wave-length can be objectively represented by a model of simple construction.

A spiral, whose diameter and pitch are respectively 2 cm. and 2·5 cm., is made of a steel wire about 1 mm. thick and hung vertically before a white screen. At a distance of a few metres we observe a very regular series of transverse waves. Another spring of exactly the same dimensions is suspended in front of the first spring so as to coincide with each other when they are seen at a distance. If one of the springs is then slightly stretched, there results a small difference in wave-length of the two sets of waves, thus causing them to strengthen in one place and destroy in the other. The distance between these



two places becomes less as the difference of wave-length increases. Figs. 1, 2, 3, 4 are the photographs of the springs suspended in the manner just mentioned, and show successive stages of interference produced by stretching the length of the second spring. The result of interference of two such waves evidently corresponds to the phenomenon of beat.

For practical purposes, two springs are suspended from a vertical board, one in front of the other, as shown in Fig. 5. Both ends of the first spring are fixed, while the upper end of the second is likewise fixed and the lower end pulled downwards by means of a string passing through a hook attached to the stand. Standing at a distance in front of the springs we can gradually stretch the second spring by pulling the string and easily observe the corresponding stages of interference in its different phases. K. HONDA.

Physical Laboratory, Imp. Univ., Tokio, Japan, May 26.

Polar Exploration.

THE following sentence is extracted from an admirable notice of the Arctic explorer, the late Baron Nordenskiöld, by Prof. A. G. Nathorst, himself renowned as an investigator of the Polar regions:—

"It may perhaps be of interest at the present time to recall the fact that we in Sweden have always taken for granted that the leader of a scientific expedition must be a naturalist, to whom the commander of the vessel has to be subordinate."—*Geograph. Anzeiger*, ii. p. 129, September, 1901.

The marked success of the Swedish expeditions, not merely in pure science, but also in geographical discovery and the safe return of their members, gives this opinion weight as well as interest. Of course it is not what the president of the Geographical Section of the British Association calls "the good old British plan." CIVILIAN.

ON THE CLUSTERING OF GRAVITATIONAL MATTER IN ANY PART OF THE UNIVERSE.

IN the Mathematical and Physical Science Section of the British Association, Lord Kelvin delivered a discourse on "The Absolute Amount of Gravitational Matter in any large Volume of Interstellar Space." Gravitational matter, according to our ideas of universal gravitation, would be all matter. Now was there any matter which was not subject to the law of gravitation? He thought he might say with absolute decision that there was. They were all convinced, with their President, that ether was matter, but they were forced to say that the properties of molar matter were not to be looked for in ether as generally known to them by action resulting from force between atoms and matter, ether and ether, and atoms of matter and ether. Here he was illogical when he said between matter and ether, as if ether were not matter. It was to avoid an illogical phraseology that he used the title "gravitational matter." Many years ago he had given strong reason to feel certain that ether was outside the law of gravitation. They need not absolutely exclude, as an idea, the possibility of there being a portion of space occupied by ether beyond which there was absolute vacuum—no ether and no matter. They admitted that that was something that one could think of; but he did not believe any living scientific man considered it in the slightest degree probable that there was space surrounding our universe beyond which there was no ether and no matter. Well, if ether went through all space, then it was certain that ether could not be subject to the law of mutual gravitation between its parts, because if it were subject to mutual attraction between its parts its equilibrium would be unstable, unless it were infinitely incompressible. But here again he was reminded of the critical character of the ground on which they stood in speaking of or giving very definite propositions beyond what they saw or felt by experiment. He was afraid he must here express a view different from that which Prof. Rücker announced in his address, when he said that continuity of matter implied absolute resistance to condensation. They had no right to bar condensation as a property of ether. While admitting ether not to have any atomic structure, it was postulated as a material which performed functions of which they knew something, and which might have properties allowing it to perform other functions of which they were not yet cognisant. If they considered ether to be matter, they postulated that it had rigidity enough for the vibration of light, but they had no right to say that it was absolutely incompressible. They must admit that sufficiently great pressure all round could condense the ether in a given space, allowing the ether in surrounding space to come in towards the ideal shrinking surface. When he said that ether might be outside the law of gravitation he assumed that it was not infinitely incompressible. He admitted that if it were infinitely incompressible, then it might be subject to the law of mutual gravitation between its parts; but to his mind it seemed infinitely improbable that ether was infinitely incompressible, and it appeared more consistent with the analogies of the known properties of molar matter, which should be their guides, to suppose that ether had not the quality of exerting an infinitely great force against compressing action of gravitation. Hence if they assume that it extended through all space, ether must be outside the law of gravitation, that is to say, truly imponderable. He remembered the contempt and self-complacent compassion with which sixty years ago he himself, he was afraid and most of the teachers of that time looked upon the ideas of the elderly people who went before them, who spoke of "the imponderables." He feared that in this, as in a great many other things in science, they had to hark back to the dark ages of fifty, sixty or a hundred years ago, and that they must admit there was something which they could not refuse to call matter, but which was not subject to the Newtonian law of gravitation. That the sun, stars, planets, and meteoric stones were all of them ponderable matter was true, but the title of his paper implied that there was something else. Ether was not any part of the subject of his paper; what he dealt with was gravitational matter, ponderable matter. Ether they relegated, not to a limbo of imponderables, but to distinct species of matter which had inertia, rigidity, elasticity, compressibility, but not heaviness. In a paper he had already published he had given strong reasons for limiting to a definite amount the quantity of matter in space known to astronomers. He could scarcely avoid using the word "universe," but he meant our universe, which might be a very small affair after all, occupying a very small portion of all the space in which there is ponderable matter.

Supposing a sphere of radius $3·09.10^{16}$ kilometres (being the distance at which a star must be to have parallax 0″·001) to have within it, uniformly distributed through it, a quantity of matter equal to one thousand million times the sun's mass, the velocity acquired by a body placed originally at rest at the surface would, in five million years, be about 20 kilometres per second, and in twenty-five million years would be 108 kilometres per second (if the acceleration remained sensibly constant for so long a time). Hence if the thousand million suns had been given at rest twenty-five million years ago, uniformly distributed throughout the supposed sphere, many of them would now have velocities of twenty or thirty kilometres per second, while some would have less and some probably greater velocities than 108 kilometres per second; or, if they had been given thousands of million years ago at rest so distributed that now they were equably spaced throughout the supposed sphere, their mean velocity would now be about 50 kilometres per second (*Phil. Mag.*, August 1901, pp. 169, 170). This is not unlike the measured velocities of stars, and hence it seems probable that there might be as much matter as one thousand million suns within the distance $3·09.10^{16}$ kilometres. The same reasoning shows that ten thousand million suns in the same sphere would produce velocities far greater than the known star velocities, and hence there is probably much less than ten thousand million times the sun's mass in the sphere considered. A general theorem discovered by Green seventy-three years ago regarding force at a surface of any shape, due to matter (gravitational, or ideal electric, or ideal magnetic) acting according to the Newtonian law of the inverse square of the distance, shows that a non-uniform distribution of the same total quantity of matter would give greater velocities than would the uniform distribution. Hence we cannot, by any non-uniform distribution of matter within the supposed sphere of $3·09.10^{16}$ kilometres radius, escape from the conclusion limiting the total amount of the matter within it to something like one thousand million times the sun's mass.

Lord Kelvin then went on to compare the sunlight with the light from the thousand million stars, each being supposed to be of the same size and brightness as our sun; and stated that the ratio of the apparent brightness of the star-lit sky to the brightness of our sun's disc would be $3·87.10^{-13}$. This ratio (*Phil. Mag.*, August 1901, p. 175) varies directly with the radius of the containing sphere, the number of equal globes per equal volume being supposed constant; and hence to make the sum of the apparent area of discs 3·87 per cent. of the whole sky, the radius must be $3·09.10^{27}$ kilometres. With this radius light would take $3\frac{1}{4}.10^{14}$ years to travel from the outlying stars to the centre. Irrefragable dynamics proves that the life of our sun as a luminary is probably between 50 and 100 million years; but to be liberal, suppose each of our stars to have a life of 100 million years as a luminary, and it is found that the time taken by light to travel from the outlying stars to the centre of the sphere is three and a quarter million times the life of a star. Hence it follows that to make the whole sky aglow with the light of all the stars at the same time the commencements of the stars must be timed earlier and earlier for the more and more distant ones, so that the time of the arrival of the light of every one of them at the earth may fall within the durations of the lights of all the others at the earth. His supposition as to uniform density is quite arbitrary; but nevertheless he thought it highly improbable that there could be enough stars (bright or dark) to make a total of star-disc-area more than 10^{-12} or 10^{-11} of the whole sky.

To help to understand the density of the supposed distribution of 1000 million suns in a sphere of $3·09.10^{16}$ kilometres radius, imagine them arranged exactly in cubic order, and the volume per sun is found to be $123·5.10^{39}$ cubic kilometres, and the distance from one star to any one of its six nearest neighbours would be $4·98.10^{13}$ kilometres. The sun seen at this distance would probably be seen as a star of between the first and second magnitude; but supposing our 1000 million suns to be all of such brightness as to be stars of the first magnitude at distance corresponding to parallax 1″·0, the brightness at distance $3·09.10^{16}$ kilometres would be one one-millionth of this; and the most distant of our stars would be seen through powerful telescopes as stars of the sixteenth magnitude. Newcomb estimated from 30 to 50 million as the number of stars visible in modern telescopes. Young estimated at 100 million the number visible through the Lick telescope. This larger estimate is only one-tenth of our assumed thousand million masses equal to the sun, of which, however, nine hundred million might be either non-luminous, or, though luminous, too distant to be seen by us at their actual distances from the earth. Remark also that it is only for facility of counting that we have reckoned our universe as a thousand million suns; and that the meaning of our reckoning is that the total amount of matter within a sphere of $3·09.10^{16}$ kilometres radius is a thousand million times the sun's mass. The sun's mass is $1·99.10^{27}$ metric tons, or $1·99.10^{33}$ grammes. Hence our reckoning of our supposed spherical universe is that the ponderable part of it amounts to $1·99.10^{42}$ grammes, or that its average density is $1·61.10^{-23}$ of the density of water.

Lord Kelvin returned to the question of sum of apparent areas, the ratio of which to 4π, the total apparent area of the sky viewed in all directions, is given by the formula (*Phil. Mag.*, August 1901, p. 175) $\alpha \doteq \frac{3N}{4}\left(\frac{a}{r}\right)^2$; provided its amount is so small a fraction of unity that its diminution by eclipses, total or partial, may be neglected. In this formula, N is a number of globes of radius a uniformly distributed within a spherical surface of radius r. For the same quantity of matter in N′ globes of the same density, uniformly distributed through the same sphere of radius r, we have $\frac{N'}{N} \doteq \left(\frac{a}{a'}\right)^3$, and therefore $\frac{\alpha'}{\alpha}=\frac{a}{a'}$. With $N=10^9$, $r=3·09\ 10^{16}$ kms.;

and a (the sun's radius) $=7.10^5$ kms.; we had $a=3{\cdot}87.10^{-13}$. Hence $a'=7$ kms. gives $a'=3{\cdot}87.10^{-8}$; and $a''=1$cm. gives $a''=1/36{\cdot}9$. Hence if the whole mass of our supposed universe were reduced to globules of density 1·4 (being the sun's mean density), and of 2 cms. diameter, distributed uniformly through a sphere of $3{\cdot}09.10^{16}$ kms. radius, an eye at the centre of this sphere would lose only 1/36·9 of the light of a luminary outside it! The smallness of this loss is easily understood when we consider that there is only one globule of 2 cms. diameter per 360,000,000 cubic kilometres of space, in our supposed universe reduced to globules of 2 cms. diameter. Contrast with the total eclipse of the sun by a natural cloud of water spherules, or by the cloud of smoke from the funnel of a steamer.

Let now all the matter in our supposed universe be reduced to atoms (literally brought back to its probable earliest condition). Through a sphere of radius r let atoms be distributed uniformly in respect to gravitational quality. It is to be understood that the condition "uniformly" is fulfilled if equivoluminal globular or cubic portions, small in comparison with the whole sphere, but large enough to contain large numbers of the atoms, contain equal total masses, reckoned gravitationally, whether the atoms themselves are of equal or unequal masses, or of similar or dissimilar chemical qualities. As long as this condition is fulfilled, each atom experiences very approximately the same force as if the whole matter were infinitely fine-grained, that is to say, utterly homogeneous.

Let us therefore begin with a uniform sphere of matter of density ρ, gravitational reckoning, with no mutual forces except gravitation between its parts, given with every part at rest at the initial instant; and let it be required to find the subsequent motion. Imagining the whole divided into infinitely thin concentric spherical shells, we see that every one of them falls inwards, as if attracted by the whole mass within it collected at the centre. Hence our problem is reduced to the well-known students' exercise of finding the rectilinear motion of a particle attracted according the inverse square of the distance from a fixed point. Let x_0 be the initial distance, $\frac{4\pi\rho}{3}x_0^3$ the attracting mass, v and x the velocity and distance from the centre at time t. The solution of the problem, for the time during which the particle is falling towards the centre is

$$\tfrac{1}{2}v^2 = \frac{4\pi\rho}{3}x_0^3\left(\frac{1}{x}-\frac{1}{x_0}\right),$$

and

$$t=\sqrt{\frac{3}{8\pi\rho}}\left(\frac{\pi}{2}-\theta+\tfrac{1}{2}\sin 2\theta\right)=\frac{\pi}{2}\sqrt{\frac{3}{8\pi\rho}}\left[1-\frac{2\theta}{\pi}\left(1-\frac{\sin 2\theta}{2\theta}\right)\right],$$

where θ denotes the acute angle whose sine is $\sqrt{\frac{x}{x_0}}$.

This shows that the time of falling through any proportion of the initial distance is the same whatever be the initial distance; and that the time (which we shall denote by T) of falling to the centre is $\frac{1}{2}\pi\sqrt{\frac{3}{8\pi\rho}}$. Hence in our problem of homogeneous gravitational matter given at rest within a spherical surface and left to fall inwards, the augmenting density remains homogeneous; and the time of shrinkage to any stated proportion of the initial radius is inversely as the square root of the density.

To apply this result to the supposed spherical universe of radius $3{\cdot}09.10^{16}$ kilometres, and mass equal to a thousand million times the mass of our sun, we find the gravitational attraction on a body at its surface gives acceleration of $1{\cdot}37.10^{-13}$ kms. per second per second This therefore is the value of $\frac{4\pi\rho}{3}x_0$, with one second as the unit of time and one kilometre as the unit of distance; and we find $T=52{\cdot}8.10^{13}$ seconds $=16{\cdot}8$ million years. Thus our formulas become

$$\tfrac{1}{2}v^2=1{\cdot}37.10^{-13}x_0\left(\frac{x_0}{x}-1\right),$$

giving

$$v=5{\cdot}23.10^{-7}\sqrt{x_0\left(\frac{x_0}{x}-1\right)};$$

and

$$t=52{\cdot}8.10^{13}\left[1-\frac{2\theta}{\pi}\left(1-\frac{\sin 2\theta}{2\theta}\right)\right];$$

whence, when $\sin\theta$ is very small,

$$t=52{\cdot}8.10^{13}\left(1-\frac{4\theta^3}{3\pi}\right).$$

Let now for example $x_0=3{\cdot}09.10^{16}$ kms., and $\frac{x_0}{x}=10^7$; and therefore $\sin\theta=\theta=3{\cdot}16.10^{-4}$; whence $v=291{,}000$ kms. per second, and $t=T-7080$ seconds $=T-2$ hours approximately.

By these results it is most interesting to know that our supposed sphere of perfectly compressible fluid, beginning at rest with density $1{\cdot}61.10^{-23}$ of that of water, and of any magnitude large or small, and left unclogged by ether to shrink under the influence of mutual gravitation of its parts, would take nearly seventeen million years to reach ·0161 of the density of water, and about two hours longer to shrink to infinite density at its centre. It is interesting also to know that if the initial radius is $3{\cdot}09.10^{16}$ kilometres the inward velocity of the surface is 291,000 kilometres per second at the instant when its radius is $3{\cdot}09.10^{9}$ and its density ·0161 of that of water. If now, instead of an ideal compressible fluid, we go back to atoms of ordinary matter of all kinds as the primitive occupants of our sphere of $3{\cdot}09.10^{16}$ kms. radius, all these conclusions, provided all the velocities are less than the velocity of light, would still hold; notwithstanding the ether occupying the space through which the atoms move. This would, I believe,[1] exercise no resistance whatever to uniform motion of an atom through it; but it would certainly add quasi inertia to the intrinsic Newtonian inertia of the atom itself moving through ideal space void of ether; which, according to the Newtonian law, would be exactly in proportion to the amount of its gravitational quality. The additional quasi inertia must be exceedingly small in comparison with the Newtonian inertia, as is demonstrated by the Newtonian proofs, including that founded on Kepler's laws for the groups of atoms constituting the planets, and movable bodies experimented on at the earth's surface.

In one thousand seconds of time after the density ·0161 of the density of water is reached, the inward surface velocity would be 305,000 kilometres per second, or greater than the velocity of light; and the whole surface of our condensing globe of gas or vapour or crowd of atoms would begin to glow, shedding light inwards and outwards. All this is absolutely realistic except the assumption of uniform distribution through a sphere of the enormous radius of $3{\cdot}09.10^{16}$ kilometres, which we adopted temporarily for purposes of illustration. The enormously great velocity (291,000 kms. per second) and rate of acceleration (13·7 kms. per second per second) of the boundary inwards, which we found at the instant of density ·0161 of that of water, are due to greatness of the primitive radius and the uniformity of density in the primitive distribution.

To come to reality according to the most probable judgment present knowledge allows us to form, suppose at many millions, or thousands of millions, or millions of millions of years ago, all the matter in the universe to

[1] "On the Motion produced in an Infinite Elastic Solid by the Motion through the Space occupied by it of a Body acting on it only by Attraction or Repulsion." Cong. International de Physique, Paris, Vol. of Report. (*Phil. Mag.* August, 1900).

have been atoms very nearly at rest[1] or quite at rest; more densely distributed in some places than in others, of infinitely small average density through the whole of infinite space. In regions where the density was then greater than in neighbouring regions, the density would become greater still; in places of less density, the density will become less; and large regions will quickly become void or nearly void of atoms. These large void regions would extend so as to completely surround regions of greater density. In some part or parts of each cluster of atoms thus isolated, condensation would go on by motions in all directions not generally convergent to points, and with no perceptible mutual influence between the atoms until the density becomes something like 10^{-6} of our ordinary atmospheric density, when mutual influence by collisions would begin to become practically effective. Each collision would give rise to a train of waves in ether. These waves would carry away energy, spreading it out through the void ether of infinite space. The loss of energy thus taken away from the atoms would reduce large condensing clusters to the condition of gas in equilibrium[2] under the influence of its own gravity only, or rotating like our sun or moving at moderate speeds as in spiral nebulas, &c. Gravitational condensation would at first produce rise of temperature, followed later by cooling and ultimately freezing, giving solid bodies, collisions between which will produce meteoric stones such as we see them. We cannot regard as probable that these lumps of broken-looking solid matter (something like the broken stones used on our macadamised roads) are primitive forms in which matter was created. Hence we are forced in this twentieth century to views regarding the atomic origin of all things closely resembling those presented by Democritus, Epicurus, and their majestic Roman poetic expositor, Lucretius.

THE CHEMISTRY OF THE CYGNIAN STARS AND BASIC ROCKS.

I HAVE recently received from Prof. Suess the following important letter, with a request that it should be sent for publication in NATURE. It is obvious that Prof. Suess' striking generalisation will lead to many interesting inquiries; for my part I shall lose no time in making the additional researches for which he asks. The results on the chromosphere spectrum obtained during the eclipse of 1898 now being published by the Royal Society will also, I think, throw some light on the question. NORMAN LOCKYER.

Vienna, October 7.

MY DEAR SIR,—In reading your highly suggestive and instructive book on Inorganic Evolution and your last papers in *Proc.* Roy. Soc. and NATURE, I was struck by what you say on the spectrum of *a* Cygni, and beg leave to submit a question.

I believe I am in accord with the best masters of geology of our time in regarding our earth as a ball of NiFe, surrounded by a silicious slag. This slag has parted (or has differentiated) into two zones, one richer in SiAl and felspathic minerals (trachyte, granite, &c.), and the other richer in SiMg (peridotite and serpentine, olivine-rock, lherzolite, dunite, kyschtymite, &c.), and both extremes are united by a host of intermediate rocks. The SiAl group is lighter, exterior and partly used up in forming sediments, the SiMg group is lower or interior and related by the universal occurrence of traces of Ni, and by other features, to NiFe. They are, in fact, the acid and the basic group of Bunsen, Durocher and all their followers.

[1] "On Mechanical Antecedents of Motion, Heat and Light"; Brit. Assoc. Rep., part ii. 1854; *Edin. New Phil. Jour.* i. 1855; *Comptes rendus*, xl. 1855; Kelvin's "Collected Math. and Phys. Papers," vol. ii. art. lxix.

[2] Homer Lane, *American Journal of Science*, 1870, p. 57; Sir W. Thomson, *Phil. Mag.*, March 1887, p. 287.

Now Prof. Vogt, of Christiania, has in a series of remarkable papers shown that the metallic ores accompanying the SiAl rocks are different from the ores of the SiMg group, and that certain metals are very characteristic for each group, and more especially for certain ultra-basic rocks. The same author has, in *Zeitschrift für prakt. Geolog.*, 1898, p. 326, given a list of the elements characteristic for the ores of each group. This list does not regard the rocks themselves, but only the ores, and I have thought to give a better approach to the sum of occurring elements by introducing a few trifling changes, viz. in noting Si, Al and also Cu on both sides, and adding C, according to South African experience, to the basic list.

(1) Acid rocks: *Si*, *K*, *Li*, Be, *Al*, *W*, *U*, *Ce*, *Y*, Cu, *Sn*, *Zr*, *Th*, B, F.

(2) Basic rocks: Si, *Ca*, Al, Ba, Sr, *Mg*, *Fe*, Mn, *Ni*, *Co*, *Cr*, *Cu*, V, *Ti*, *Pt* and allied metals, *C*, P, *S*, Cl.

(The most characteristic members are italicised.)

The ultra-basic rocks have their exact equivalent in the meteoric stone of Chassigny.

The great number of analyses of meteor irons by Cohen recently published by the Berlin Academy gives Fe, Ni, Co, Cr, Cu, C, P, S, Cl, joined in single cases by SiO_2, MgO and CaO. You know that Davison also found Pt and probably Ir. It is Vogt's list of metals from basic rocks.

Ångström's older list of Fraunhofer lines gives H and Na, and besides these Ca, Ba, Mg, Fe, Mn, Ni, Co, Cr and Ti.

These are all elements accompanying the basic rocks, and although your own later observations show the existence of lines of some of the characteristic metals of the acid series, such as K, Li, U and Ce, I must conclude that Vogt's basic list is more distinctly represented in the sun's absorbing layer.

Now your comparison of the sun's chromosphere with the enhanced lines of *a* Cygni gives a quite similar list for *a* Cygni: Mg, Ca, Fe, Ti, Mn, Ni, Cr, V, Cu, Sr, and the impression is that the metallic vapours, which accompanied the intrusion of ultra-basic rocks and sometimes, as in Norway, gathered as ores at the circumference of these ultra-basic intrusive rocks, must have been of a remarkable likeness to those of the sun's chromosphere and of *a* Cygni.

One might even be induced to go a step further. Among the ores of the ultra-basic rocks Vogt distinguishes two varieties, which he calls the oxydic, characterised by the prevalent occurrence of Ti, and the sulfidic ores (nickeliferous pyrrhotite). And I find that you remark γ Cygni to be distinguished by the prevalence of Ti, *a* Cygni by Fe, Cr and Ni, and β Orionis by Si and Mg—corresponding to these two varieties of ores and to the intrusive rock SiMg (β Orionis being the country rock of the ores). But I am very far from proposing any conclusions whatever in this imperfect state of knowledge, and only venture to point out the interest which is attached to the examination of a number of elements named by you on p. 58, "Inorganic Evolution"—which have only been investigated by you with lower dispersion, and which embrace several typical representatives of the acid series—and to the special research of metals like W, U, Ce, Sn and others of this series.

The question, which I take leave to submit, is: Have we indeed to suppose that metallic vapours answering to metals from acid rocks are less represented in the sun and stars than those from basic rocks, or is it some secondary cause, the nature of their spectrum or other, which gives the present seeming prevalence to the metals from basic rocks?

I beg you, dear sir, to accept the expression of my highest esteem.

Yours most respectfully,

EDW. SUESS.

RUDOLPH KOENIG.

THERE has passed away in the person of Dr. Rudolph Koenig one whose name will be remembered in the science of physics, and who filled a unique place. To the outer world he was known simply as a maker of tuning-forks. To the inner circle of science he was known as the author of original researches in a line peculiarly his own. To the few who had the privilege of an intimate acquaintance he was known as a simple-hearted, whole-souled devotee of his chosen science of acoustics: one who lived for and loved his work.

Born at Königsberg in 1833 of a family connected with the University, he was himself trained in the Philosophical Faculty of that famous centre. He graduated as Doctor of Philosophy, and well might have looked forward to a successful career as professor of physics in one of the Universities of his native land. What cross-currents of destiny drove him far afield are not clearly known to the present writer. But the year 1860 saw him established in Paris as a constructor of acoustical instruments, carrying out the traditions of fine workmanship established by Cavaillé-Coll. He had an *atélier* in the Place du Lycée Louis le Grand, and here he worked out a number of new acoustical instruments. The phonograph, or phonautograph as it was later called, of M. Scott de Martinville for recording the vibrations of tones and words was brought to Koenig to be put into shape. Accounts of this instrument will be found in *Cosmos*, vol. xiv., in the *Athenaeum* of 1859, and in the Report of the British Association for the same year. It was Koenig's part to devise a better mouthpiece and a more sensitive membrane. He also devised the recording drum, driven on an axis cut with a screw thread. I once asked him whether, when he was working with M. Scott on this instrument, it had not occurred to either of them that the record of the vibrations might not be used over again to reproduce the sound, as discovered nearly twenty years afterwards by Edison. His reply was: "No, the idea never occurred to either of us; we never thought of anything except recording." He constructed series of standard tuning-forks furnished with recording styluses; he improved the mechanical construction of the Seebeck siren; he studied the vibrations of plates and of columns of air. In 1862 he brought over to London to the second of the series of International Exhibitions a fine set of his new apparatus, including an acoustical album or collection of graphic tracings recording the composition of vibrations; and for the exhibit he was awarded a gold medal. About the same time began the publication of his experimental researches in acoustics which lasted nearly forty years. The earliest of these to be noted was the invention of the manometric flame. Organ pipes fitted with manometric capsules for investigating the vibrations of the air column by means of gas-flames were shown in the London Exhibition of 1862, and they were described by him in vol. cxxii. of Poggendorff's *Annalen*, pp. 242 and 246, of the same year. He constructed resonators for Helmholtz (see Appendix I. of the first edition of the "Tonempfindungen," 1863); he repeated the experiments of Philipp Reis with the primitive telephone of that neglected inventor; he devised a new stethoscope furnished with one or more flexible rubber tubes to admit of simultaneous auscultation by several observers. In the *Comptes rendus* of March 1864 he had a memoir upon the vibration of plates, in which he discussed the sound-figures in sand discovered by Chladni and the explanation of their formation then recently suggested by Wheatstone. In 1870 he had another article in the *Comptes rendus*, on the fixed notes which are characteristic of the different vowels. In 1872 came a second memoir on manometric flames in the *Annalen*.

During these ten years Koenig had been attempting to build up the business of manufacturer of acoustical instruments. His standard tuning-forks were sought after by physical investigators. The impulse given to acoustical subjects by the publication of the famous book of Helmholtz was undoubtedly great; and the researches of Chladni, Wertheim, Melde, Terquem, Wheatstone and Mach were claiming great attention. Koenig adopted the suggestion, urged by Chladni in 1830, of fixing as the normal scientific pitch for his standards that in which middle C of the keyboard is assigned to 256 complete vibrations per second. In the "Catalogue of Acoustical Apparatus" which Koenig published in 1865—itself an evidence of his scientific and industrial activities—he notified his adherence to this standard for the *diapason normal*. He had now moved into the Rue Hautefeuille on the south side of the Seine, where he lived and worked until about 1878, when the house was demolished in the construction of the Boulevard St. Germain through the Quartier Latin. Unhappily the outbreak of the Franco-Prussian War rendered it difficult for a German to live in Paris. Of a retiring and sensitive disposition, he found himself somewhat isolated in his work. The scientific world was rather cold toward the man who made a living out of selling tuning-forks. Other instrument makers began to copy his instruments, and were able, not having the same scientific ideals, to undersell his manufactures by producing less carefully-made articles. Koenig never swerved one hair's breadth to meet this competition. He knew the quality of the work that left his little factory. Not one tuning-fork, during these more than thirty years, left the place without having been personally adjusted and verified by him. No single instrument of second quality ever bore his mark. The monogram "R. K." stamped upon his work became an absolute guarantee of first-rate workmanship. Others might cheapen their manufacture by neglect of quality: he would maintain the quality of his *coute que coute*. If by some stroke of luck he sold instruments that brought in a few hundred francs above the regular income of his business he would hail it as the means of constructing some new piece of experimental apparatus that might never find a sale, but would help his investigations. And so with a slender business and a few faithful workmen at his back he maintained a proud independence, sufficient to enable him to continue research.

In 1876 he went over to America and took with him to the Centennial Exposition at Philadelphia a splendid series of his beautiful instruments in the hope of doing advantageous business. The Jury's report of the awards in Group xxv. speaks in glowing terms of this effort. "In the present Exhibition," it runs, "Dr. Koenig has presented a collection of instruments of demonstration and investigation constructed on a scale of magnitude heretofore unattempted, and exhibiting with surprising power the effects of interfering undulations. He also presents a tonometric apparatus, consisting of about 670 diapasons or tuning forks, giving as many different shades of pitch, extending over four complete octaves, and making equal intervals of eight simple vibrations each for the first octave, and of twelve each for the succeeding octaves; the whole forming an absolutely perfect means of testing, by count of beats, the number of vibrations producing any given musical sound, and of accurately tuning any musical instrument. In addition to these more conspicuous portions of his display, Dr. Koenig exhibits the various forms of apparatus of demonstration for which he is so well known, all of which are marked by the accuracy of indications and excellence of workmanship which have given him his deserved reputation as a constructor." . . . "Of the exhibit of Dr. Koenig, as a whole, it may be said that there is no other in the present International Exhibition which surpasses it in scientific interest." The interest excited by this exhibit was so great that an appeal was circulated, signed by Joseph Henry and others, suggesting the purchase of the instruments. Koenig was induced to leave them at the University of Pennsylvania under promise of their being insured for 10,500 dollars and of a weekly account of the subscription being sent to him. But after a long and vain expectation of the weekly accounts, and the writing of many unanswered letters, it became evident to Koenig that things were going wrong. In June 1878 Mr. Munzinger, who had undertaken to collect the funds, announced to Koenig that he had remitted the whole subscription to Prof. Barker, but on December 15, 1879, Prof. Barker wrote: "Mr. M. has not yet turned over to me the subscription for the acoustical collection." On June 30, 1882, he again wrote: "With regard to your collection, I have been entirely unable to complete the subscription for its purchase." There remained nothing for Dr. Koenig to do but to go over and remove the collection. A portion of it was sold at some sacrifice to the University of Toronto, the physical collection of which it adorns; while the rest was brought back to Paris. The incident had the most unfortunate effect on Dr. Koenig. It crippled his slender resources for more than ten years, and it tended to sour his sensitive temperament. He had in 1876 communicated to Poggendorff's *Annalen* two papers, one on a tuning-fork of variable pitch, the other upon the phenomena produced by the interference of two tones. This latter paper is one of the undoubted classics of science. Using the most splendid and perfect of all tone-producers, the substantial steel tuning-forks of his own design, he had for years been investigating the phenomena of beats and the production of interference-tones. Applying the phenomena of beats every day in his workshop for the purpose of adjusting forks to their exact pitch, he acquired a familiarity with the phenomena such as no other experimenter could possibly attain. His published research is a model of careful and accurate observation. Helmholtz had given the well-known theory that when two tones are sounded together there are produced two other tones, known as the difference-tone and the summation-tone, having frequencies respectively corresponding to the difference and the sum of the frequencies of the two fundamental tones. Koenig, finding himself unable to confirm the existence of these alleged tones, set to work to find out what the actual facts were. He investigated both the beats and the resultant tones. He found that primary beats were not all of one kind; that they could be ranged in two sets, an inferior and a superior set. Of these the inferior alone correspond to the difference of the frequencies, and so correspond only in the first octave. Outside the first octave neither set of beats corresponds either to difference or to sum. He found that when with higher forks resultant tones are produced they likewise may be ranged in two sets, an inferior and a superior set, the pitch of these resultant tones being always precisely that calculated as for beats. These resultant tones are never either summation-tones or difference tones except for tones within the range of the lower half of the first octave of relative pitch, within which limits alone they correspond to the difference of the frequencies. Outside that limit there are no difference-tones. Under no circumstance, when pure notes are used as the two fundamentals is the alleged summation-tone heard. It is true that Prof. Rücker has by the most refined optical appliances demonstrated the objective existence of the summation-tone. But the source was a powerful siren which notoriously generates an impure tone. Koenig's statement of 1882, "Je ne connais jusqu'à present aucune expérience par laquelle on pourrait prouver avec quelque certitude l'existence de sons différentiels et de sons d'addition," remains absolutely true to-day. During the years that followed the unhappy incident of 1876 Koenig continued his investigations. Amongst the apparatus at Philadelphia was the first of his wave-sirens, a novel instrument which for the first time enabled the experimenter to build up synthetically a complex tone out of harmonic constituents in such a way as to vary at pleasure the phases of the component tones. He had discovered that, contrary to the theory of Helmholtz, phase-difference does exercise a modifying effect upon the timbre, and is physiologically observable. This theme he developed in a memoir entitled "Bemerkungen über die Klangfarbe," which was published in *Wiedemann's Annalen*, vol. xiv., in 1881. For this research he constructed a large new wave-siren on a different plan. The same instrument enabled him to investigate the properties of tones produced by a succession of irregular waves. In 1882 he published, under the title of "Quelques Expériences d'Acoustique," a volume of 243 pages resuming his experimental researches down to that date. This volume is now very scarce: it is a veritable treasury of careful and refined experimental investigation. Of these acoustical researches a summary was given by the present writer in NATURE some years ago. In 1890 Dr. Koenig brought over to London his large wave-siren and a number of the larger tuning-forks, and himself demonstrated the principal points of his researches before a meeting of the Physical Society. These instruments were also shown at the Royal Institution in June of the same year at a Friday evening discourse on the physical basis of music. A few of the forks were acquired for the National Collection at South Kensington.

On recovering in the autumn of 1882 the unsold portion of his acoustical collection, he proceeded to reconstruct, on a larger scale than before, the great tonometer, the series of standard tuning-forks which originally extended in unbroken series only from the frequency of 128 to that of 4096 vibrations. He added massive steel forks, some of them weighing nearly 200 pounds, taking the frequency down to 16, while at the higher end of the scale he added several octaves, so that eventually he reached a pitch above the superior limits of ordinary audition. One of his latest researches was, indeed, upon the verification by the method of Kundt of the wave-length of these inaudible forks, going up to 45,000 vibrations per second. This splendid set of standard instruments has remained until now in Dr. Koenig's *atélier*. An attempt was made about three years ago—unfortunately without success—to secure it for the National Collection of Scientific Apparatus at Kensington. It can never be duplicated, and its dispersal would be a misfortune for science.

Dr. Koenig suffered during his last years from much broken health. He never married, but lived alone, surrounded by the instruments of his creation, in his workshop on the Quai d'Anjou. Here he received from time to time the visits of his friends. The late Mr. Spottiswoode used frequently when passing through Paris to visit him. A brief word of announcement that one would give oneself the pleasure of calling next Sunday morning always found Koenig ready and pleased to spend an hour in showing his latest experiments. The last time that I had this opportunity was during the Electrical Congress in September 1900. He had during the preceding week had a similar visit from Lord Kelvin. Koenig was even then very ill. He suffered terribly in body and was obviously feeble. For some months he had lived on nothing but milk. But he was as animated and keen as ever. He had some new observations and a new instrument—no account of which has been published—demonstrating the influence of phase upon the quality of compound tones. They were simple and convincing. But the occasion was mournful; his bodily sufferings were only too evident. He wrote me in the spring of the present year that his health was still more precarious. He died on October 2, 1901, aged sixty-eight years.

Dr. Koenig was an honorary fellow of the Physical Society of London. He had received few tokens of recognition from academies or learned societies; and this one, conferred only last February, gave him evident pleasure. But his work, so courageously maintained in the true spirit of scientific devotion, will remain as his monument to all time. S. P. T.

THE McCLEAN TELESCOPE AT THE CAPE OBSERVATORY.

WE have on many occasions recorded munificent gifts towards scientific research and education from wealthy Americans and others, and now and again it has been our pleasurable duty to call attention to instances of similar generosity on the part of our own countrymen. Naturally it is more gratifying for us to record the latter than the former, especially, perhaps, as the occasions are less frequent. The weekly edition of the *Cape Argus* for October 2 instances a notable example of such a gift in its account of the ceremony which took place recently of the unveiling, by his Excellency the Governor (Sir W. Hely-Hutchinson), of the inscription stone of the magnificent telescope which Dr. Frank McClean, F.R.S., has presented to the Royal Observatory at the Cape. This telescope was offered and accepted some years ago, but many delays have occurred.

Says our contemporary: "The pleasant little ceremony . . . deserves more than passing mention. It gives an opportunity for the cultivation of a virtue which is not too common at the Cape—the virtue of gratitude which Shakespeare knew as a 'noble thankfulness.' And if for the nonce the public should be led to depart from its usual Philistine attitude towards pure science and the higher walks of research, the change may not be ungraceful, and may do it good. The value of Mr. McClean's gift it would be hard to overestimate. In mere money's worth it was princely—more than the Imperial Government could well spare, and more than the Colonial Government could venture to dream of as an encouragement to unapplied science. It was given, too, at the right time and to the right place, there being immediate need for a wide development of spectroscopic work, and the southern hemisphere being poorly supplied with astronomical equipment compared with the affluent north. Further, it did not come from a mere millionaire, willing to be moderately fleeced in return for a little notoriety; Mr. McClean was a skilled and assiduous worker in this branch of science, and what he gave was the outcome of a pure heart and a noble enthusiasm. Nor did he stop at the purely material gift, but gave time and thought and trouble to make sure that the telescope and its accompaniments should be fit for the performance of the very best type of work. He came to the Cape and resided for months here, and those who were privileged to meet him will always remember his unassuming ways and his unflagging interest in his work. He had a double purpose in coming, and by far the greater portion of his time was spent in obtaining the spectra of certain southern stars, in order to supplement his similar work in the north. When this was done, the kindly English gentleman left as quietly as he came. The scientific equipment of the Colony had been handsomely enriched by him, but so far as the general public was concerned he left 'unhonoured and unsung.' . . . The need of scientific and literary endowments at the Cape is well known, and the forgetfulness of those whom the land has made wealthy is occasionally bewailed: it would ill become us, therefore, to be equally forgetful of the far-seeing liberality of a stranger who owed us nothing."

The proceedings were opened, in the presence of a distinguished company, by Sir David Gill, K.C.B., F.R.S., His Majesty's Astronomer at the Cape, who delivered an address, space for which we regret to be unable to spare, after which Sir W. Hely-Hutchinson, in the course of a brief speech, said that in regard to the magnificent gift which Mr. McClean had made to the Observatory, he ought to say that it was the desire of H.R.H. the Duke of Cornwall and York to have performed the ceremony which he (the Governor) was now inadequately to undertake. The fact that the telescope had been named the "Victoria Telescope" was, doubtless, one reason which had actuated His Royal Highness in this regard, but the fact that so handsome—he might say, so princely—a gift had been made to science deserved the full recognition of the highest in the land. His Royal Highness not having been able, however, to unveil the inscription stone, owing to the great number of engagements which were pressed upon him during his recent visit, it had fallen to his (the Governor's) part to do so.

The whole company then proceeded to the outside of the building, where his Excellency removed the Union Jack which covered the inscription stone. The inscription was simply as follows:

1897: The Victoria Telescope.
The Gift of Frank McClean,
of Rusthall, Kent.
David Gill, H.M. Astronomer.

While assembled round the stone cheers were given, first for the donor of the telescope and then for the Governor, and the proceedings terminated.

THE NERNST LAMP IN AMERICA.

THE paper read last August by Mr. A. J. Wurts at the annual convention of the American Institute of Electrical Engineers on the development of the Nernst lamp in America is especially interesting as being practically the first to contain any full description of the physical characteristics of the Nernst filament, or "glower" as it is generally called to distinguish it from the carbon filaments of incandescent lamps. It is interesting, too, in that it affords evidence that the lamp is eventually emerging from the laboratory stage and becoming a really trustworthy commercial article. It will be remembered that shortly after Nernst's invention was made public the commercial development of the lamp was taken up by four companies—by the Allgemeine Elektricitäts Gesellschaft in Germany, by the Westinghouse Company in America, by the Nernst Electric Light in England and by Ganz and Co. in Austria. The German company, who possess the patent rights for most of Europe, including England, have for some time had the lamp on the market in Germany, and, as their exhibit at the Glasgow Exhibition shows, are now introducing it into this country. The Westinghouse Company have also, to judge by the paper by Mr. Wurts, developed the lamp to a degree justifying its introduction into commercial use in America. Three or four years may seem to some a long time to have spent on the improvement of Nernst's invention before it could be considered practically available, but when the great complexity of the lamp as compared with an ordinary incandescent lamp is taken into account it cannot be regarded as excessive.

We propose to consider briefly some of the electrical properties of the glower as described by Mr. Wurts rather than to give a detailed account of the mechanical construction of the lamp. Those who take an interest in this side of the subject may be referred to the *Electrical Review* of New York for August 31 and September 7, in which will be found a full reprint of the paper and a short summary of the discussion which it raised. The glower, as is well known, is made of a mixture of oxides similar to those used in the manufacture of Welsbach mantles, which are mixed to a paste and then pressed through a die into threads of the desired thickness. These threads are cut into convenient lengths and baked, after which leading-in wires are affixed to the ends. This connection, as originally made by Dr. Nernst, consisted of a few turns of platinum wire twisted round the ends of the glower and cemented to it by a suitable paste; the terminal connection worked out by the Westinghouse Company has the platinum lead wire terminating in a small bead which is actually embedded in the end of the glower, the object being to prevent any shrinking of the glower spoiling the contact between it and the platinum. It has often been stated that if the current through a glower be altered, the potential difference between its ends falls as the current is increased. The curves published by Mr. Wurts show that for a glower burning in air this statement is not quite correct; the curves only give the characteristic of the glower between 0·3 and 0·65 ampere, but they show that as the current is increased from 0·3 to 0·5 ampere the potential difference rises also, from 180 to 197 volts; the potential difference remains constant as the current is further increased up to 0·55 ampere, after which it begins to fall slightly. It is, however, quite evident that if the glower is run anywhere near the crest of this curve, as is the case in practice, a steadying series resistance is essential, especially on a circuit in which the voltage fluctuates, as it does on all the supply circuits with which we are acquainted.

In the above respect the glower behaves in a manner comparable with the arc rather than with the carbon filament. The behaviour is generally accounted for by saying that the glower being an electrolytic conductor becomes less resisting as its temperature is increased. That the phenomenon is, however, more complex than this is shown by the characteristics of the glower in other gases than air, or in a vacuum. For a glower burning in oxygen the characteristic appears to be almost identical with the air curve; when nitrogen is used the curve is similar in shape, but the maximum voltage occurs at a lower current and is about 4 per cent. less in magnitude. The characteristics for hydrogen and a vacuum show only a falling curve; there is no portion within the same current limits in which the potential difference rises with the current. These results seem to indicate that some chemical changes are going on between the glower and its surrounding envelope of gas which have an important influence on its behaviour and very possibly on its efficiency and life. There can be little doubt that when the Nernst lamp is easily available it will open up a field of research as interesting and possibly as fruitful as that afforded by the electric arc.

The work of M. Blondel and Mrs. Ayrton has made us familiar with the physical necessity of a resistance in series with the arc on account of its falling characteristic. Such a resistance is still more necessary with the Nernst glower—since a smaller overload of current is more dangerous. With an arc a comparatively small "dead" resistance in series is sufficient, that is to say a resistance which remains of practically constant value throughout the working range of current and does not heat sufficiently with a small overload to alter appreciably. But with the glower it is easy to see, from the curves published by Mr. Wurts, that if a dead resistance were used it would have to be so large for safety as to greatly diminish the efficiency of the complete lamp. A resistance has therefore had to be sought which will increase very rapidly with increase of current, and the solution of the difficulty has been found in using fine iron wire nearly at a red heat, the wire being enclosed in a small sealed bulb filled with hydrogen to prevent its oxidation. This "ballast," as it is named by the Westinghouse Company, has a remarkably high corrective power; with a rise in current of 15 per cent. the resistance increases about 180 per cent., the potential difference between its terminals increasing 200 per cent. As a consequence with such a ballast in series with the glower, a rise in the supply pressure does not produce a serious increase in the current. It follows also that the Nernst lamp (consisting of glower and ballast) cannot be overrun in the same way as an incandescent lamp in order to get it to give more than its rated candle-power or to work at a higher efficiency. With an increase of the supply pressure of 5 per cent. the candle-power of an incandescent lamp increases 40 per cent., whereas that of the Nernst lamp only rises about 7 per cent., the corresponding increase in efficiency being 26 per cent. and 2 per cent. respectively. It is obvious that as this result is attained by running the iron wire nearly at a red heat, the resistance of the ballast when cold is considerably lower than its correct working resistance, and there is therefore a tendency for the glower to take too much current when it first lights up. The ballast has for this reason to be constructed in such a way that the iron wire shall very quickly assume its full resistance, a requisite satisfied by the free suspension of the wire in the hydrogen bulb.

Mr. Wurts does not give any curves showing the candle-power and efficiency during the life of the glower, a thing to be regretted, as it is by the performance of the lamp in this respect that it must ultimately stand or fall. It is, however, stated that the average life of 220-volt glowers on a by no means over steady alternating circuit was found to be from 800 to 900 hours, and that neither the efficiency nor the candle-power fell off much during this life. The life of the 110-volt glowers is said not to be so good, and the average life of the glowers on direct current is given as only about 250 to 300 hours. It should not be assumed that this is an inherent defect, as the Westinghouse Company have devoted their attention mainly to alternating current, and since the German company make lamps for either type of supply it seems evident that the difficulty can be overcome.

We have done no more than indicate a few of the many interesting considerations raised by Mr. Wurts' paper; it contains in addition descriptions of the heater, of the cut-out used for breaking the heater circuit when the glower lights, and of the complete lamp as now constructed in America. Suffice it to say that the lamps are made in candle-powers from 50 to 2000, the higher candle-powers being obtained, not by the use of a larger glower, but by mounting a number of glowers in parallel in the same lamp. Smaller candle-powers than 50 have not been made, as it has been deemed advisable to design the lamp to compete with the arc rather than with the incandescent lamp. In conclusion, we must agree with Mr. Steinmetz, the president of the American Institute, that the lamp should not be compared too severely with existing standardised lamps since, as it is just fresh from the laboratory, it is to its promise rather than to its performance that one should look. And there can be little question but that its promise is exceptionally good.

FLORAS OF THE PAST.[1]

THIS "extract" from the twentieth annual report of the U.S. Geological Survey forms a bulky volume of more than 200 pages and 150 plates. Prof. Lester Ward tells us in the introductory remarks that the aim of the memoir is "to give a succinct account of the progress thus far made in the direction of developing the Mesozoic floras of the United States." The present instalment deals with the vegetation of the Triassic and Jurassic

[1] "Status of the Mesozoic Floras of the United States." First Paper: The Older Mesozoic. By Lester F. Ward, with the collaboration of W. M. Fontaine, A. Warner and F. H. Knowlton. Pp. 211–430 + Plates xxi–clxxix. (Washington: Government Printing Office, 1900.)

periods, the Cretaceous floras being reserved for a second part. The numerous scattered references to the Mesozoic botany of the United States, and the conflicting opinions that have been expressed as to the geological age of the plant-bearing beds, enable us to thoroughly appreciate the value of a comprehensive report compiled by one who possesses a wide knowledge of palæobotanical literature. It is, however, not solely with published facts that the volume is concerned, for a large portion of it is devoted to a systematic account of recently discovered species. The Triassic floras are represented by fossils from the Connecticut Valley, Pennsylvania, Maryland, Virginia and other regions, while plants of Jurassic age are described from California, Oregon and Wyoming. One of the chief desiderata from the point of view of palæobotanical research is a careful and critical examination of the records of ancient floras, which may be of use in the consideration of the broad problems connected with plant evolution and distribution. In the treatment of work of this kind it is essential to carefully weed out such material as cannot be determined with sufficient accuracy to furnish trustworthy evidence. This obvious reflection is suggested by a perusal of the numerous determinations and descriptions contained in the volume before us. It is unfortunate that the plants from the Jurassic strâta of California (the Oroville flora) are in most cases represented by fragmentary samples, and in several instances these have been referred to genera and species on evidence which cannot be accepted as satisfactory. Systematic work on fossil plants has too frequently been marred by a want of self-control on the part of authors who appear to be led away by a desire to attach names to specimens that are absolutely valueless as botanical records; we are compelled to add that the utility of the descriptive portions of this work is seriously impaired through lack of courage to discard worthless material. More than eighty specimens of cycadean stems are recorded from the Freezeout Hills of Wyoming—probably of Jurassic age. These stems are referred by Prof. Ward to a new genus, *Cycadella*, which is described as being characterised by the relatively small size of the trunks and by a dense covering of ramental tissue "exuberantly developed from the leaf-bases and extruded from the armour, massed and matted in the fossil state so as to form a thick outer covering." The exceptional development of the ramental scales suggests a comparison with the abundance of woolly hairs on the carpophylls of the recent cycadean genus *Dioon*, and constitutes an interesting feature which may serve as an index of climatal conditions.

The characters on which the cycadean stems are referred to distinct species are hardly such as to deserve specific recognition, and in looking over the numerous plates devoted to the specimens, one fails to appreciate the advantages gained by the reproduction of more than a hundred photographs, in most cases exhibiting only surface features which are often indistinctly shown and give little or no information of botanical value. Prof. Ward admits that the characters made use of in his classification are not the most satisfactory for diagnostic purposes, but we would urge that in the absence of more useful characteristics, such as might be obtained from an examination of the anatomy of the petrified stems, the application of specific names serves no useful purpose, but rather tends to confusion. Little information is given in regard to the reproductive organs; these are described as being less numerous than in other fossil cycads, but they appear to agree in position and in form with those of the *Bennettites* type.

There is no more striking feature of the Mesozoic vegetation of the United States than the extraordinary abundance of silicified cycadean stems, and no more valuable contribution could be made to our knowledge of extinct types than a comparative morphological account of the vegetative and reproductive organs of the American fossil cycadales. A foretaste of what may be expected has been supplied by Mr. Wieland, who has already published some descriptions of the reproductive organs of cycadean plants in the large collection at Newhaven; it is an extension of this kind of work that is urgently needed and for which there appears to be no lack of material.

Some pieces of coniferous wood are described by Mr. Knowlton and referred by him to *Araucarioxylon? obscurum*, n.sp., but in this case also the data are insufficient to justify the adoption of a distinctive specific name.

Apart from these criticisms as to the methods adopted in the systematic part of the work, we can cordially congratulate Prof. Ward on the completion of the first part of a research which must be of great value to students of palæobotany. A. C. S.

NOTES.

WE are glad to notice that the daily Press is endorsing what we have for years been endeavouring to bring home to the nation, viz. a better appreciation of the advantages of science and of scientific training. A notable instance of this is to be found in a leader in the *Times* of Monday last on the anniversary of Trafalgar, in the course of which our contemporary, in speaking of the recent naval disasters and breakdowns, says that these mishaps "suggest, if they do not indicate, some failure of competence, some lack of coordinating intelligence, among those who are responsible for the structural perfection of our warships. If this were so, it would tend to show that the national failing of which we have seen too many evidences of late, of neglect of scientific training, of the practical man's contempt for scientific method, of self-satisfied contentment with the traditional, the makeshift and the second best, is beginning to find its way into the constructive and engineering departments of the Admiralty." "We have heard much of late," remarks our contemporary, "about the need for 'standardising' our machines. Let us try if we cannot 'standardise' our educational methods and our intellectual equipment generally—not, indeed, according to the 'standards' of the Education Department, but according to the standard of the best that is known, and thought, and done in the world. In the Navy of to-day," says the *Times*, "there is zeal, capacity, energy and devotion in all respects worthy of the heroic past. The only thing that seems to be wanting is what is wanting in the nation, belief in knowledge and faith in applied intelligence." We trust that at this time, when we are being outstripped in many directions by foreign rivals, and commercial invasion has come to our very doors, and orders for machinery, railway locomotives, &c., are going in increasing numbers to our more energetic and receptive kinsmen across the sea, such words of warning as we have quoted will receive due attention and be acted upon ere it be too late.

THE question of fogs in London is at last, we are glad to see, to receive attention. The General Purposes Committee of the London County Council having had under consideration a letter from the secretary of the Meteorological Office, stating that it is proposed to hold an inquiry into the occurrence and distribution of fogs in the London district and their relation to other atmospheric and local conditions, and asking for the co-operation of the Council in the conduct of the inquiry, propose "(1) That a gentleman of suitable scientific qualifications be engaged by the Meteorological Council for a limited period, to formulate instructions and a scheme of observations, and to conduct the investigation; (2) that the observations be taken at the various Fire Brigade stations, and by men of the Fire Brigade; and also, if it can be so arranged, at other institutions of the London County Council; (3) that the returns be sent from the various stations, and from any other institutions selected, direct to the

Meteorological Office; (4) that the Meteorological Council do arrange with the police authorities for observations to be taken at selected positions outside the County of London; (5) that all responsibility as to the conduct of the investigation and any published results of such investigation do rest with the Meteorological Council; (6) that a copy of the complete returns and twelve copies of a report thereon by the Meteorological Council be supplied to the London County Council, and that the London County Council do contribute a sum of 250*l.* for the investigation." The steps about to be taken are most important, and should certainly lead to very valuable results.

THE second annual Huxley lecture of the Anthropological Institute will be delivered by Mr. Francis Galton, F.R.S., at the rooms of the Society of Arts, John Street, Adelphi, on the 29th inst., at 8.30 p.m. The subject chosen by the lecturer is "The Possible Improvement of the Human Breed under the Existing Conditions of Law and Sentiment." Tickets may be obtained on application at the Institute, 3, Hanover Square, W.

THE Frankland memorial lecture will be delivered before the Chemical Society by Prof. H. E. Armstrong, F.R.S., on Thursday next at 8.30 p.m.

THE opening meeting of the session of the Institution of Electrical Engineers for the presentation of premiums and the delivery of the presidential address will take place on Thursday, November 21, instead of on November 14 as was previously announced.

ARRANGEMENTS are being made for the next congress and exhibition of the Sanitary Institute to be held at Manchester in September, 1902. Earl Egerton of Tatton has accepted the presidentship, and the use of the Owens College buildings has been granted by the senate for the sectional meetings and as reception rooms. The exhibition will be held in the St. James's Hall.

THE eleventh Congress of Russian Naturalists and Medical Men will be held in St. Petersburg from January 2 to 12, 1902. There will be sections devoted to mathematics and mechanics, astronomy and geodesy, physics, physical geography, chemistry, geology and mineralogy, botany, zoology, anatomy and physiology, geography (with a subsection relating to statistics), medicine and hygiene, and agronomy.

THE next International Geographical Congress will be held in 1904 in Washington, under the auspices of the National Geographic Society, the president of the latter, Dr. Graham Bell, having just heard from Baron von Richthofen, president of the executive committee of the last Congress, of the acceptance of the invitation to Washington which had been tendered by the Society. In consequence of the decision of the executive, and in view of the coming Congress, the October issue of the *National Geographic Magazine* contains a brief account of the meetings of the Congress which have already taken place, and gives a list of possible excursions in America, each of which would be a geographical lesson.

THE new bacteriological department of the Royal Infirmary, Bristol, will be opened to-morrow by Sir Frederick Treves, K.C.V.O., who will afterwards distribute the prizes to the successful students in the Faculty of Medicine of University College, Bristol, and preside at the annual dinner of the Medical School.

PARIS was greatly excited on Saturday last when M. Santos Dumont, with his seventh balloon, successfully rounded the Eiffel Tower and returned to the shed at St. Cloud, thirty seconds within the thirty minutes allotted by the Committee of the Deutsch Prize. At the time of the voyage the wind, according to the *Times* correspondent, was blowing at the rate of twelve or thirteen miles an hour. At one period the balloon, travelling at the rate of thirty miles an hour, appeared as though it would collide with the Tower; the aëronaut, however, was able to control its movements without any apparent difficulty, and, as has been said, the journey was accomplished within the time limit agreed upon. M. Santos Dumont is to be congratulated upon the success which has at last attended the untiring efforts put forward by him towards the solution of the problem of aërial navigation.

THE death occurred last week, in his fifty-sixth year, of Dr. James Foulis, of Edinburgh. In 1872, at the suggestion of Prof. (now Sir William) Turner, he began to study the structure of the ovary and the development of the ova, more especially in reference to the then recently published work of Waldeyer. In 1874 the degree of M.D. and the gold medal for a thesis on this subject was conferred on him. The following year, having made many additional observations on the anatomy of the ovary, he contributed a paper to the Royal Society of Edinburgh on the development of the ova in man and other mammalia, which was published in the *Transactions* of the Society. Dr. Foulis published other papers, and in 1875 obtained the first award of the Prof. John Goodsir memorial prize for the encouragement of the study of anatomy and physiology.

WE regret to have to record the death of Canon Isaac Taylor, which took place on Friday last in his seventy-third year. Canon Taylor was the author of, among other works, "Words and Places," "Names and their Histories," "Etruscan Researches," "Greeks and Goths, a study in the Runes," and "The Alphabet, an account of the History and Development of Letters." He was one of the founders of the Alpine Club, and took great interest in gardening and entomology.

THE death is announced of Privy Councillor Maercker, professor of agricultural chemistry at the University of Halle.

AN interesting and valuable gift has just been made to the Ashmolean Natural History Society of Oxfordshire by Mr. Henry Willett, of Brighton, and consists of a piece of ground about five acres in extent, comprising woodland, marsh bog and water, which contains many local and rare specimens of animal and vegetable life. It is the wish of the donor that the land shall be known as "The Ruskin Plot," and that it shall be kept for all time in its natural condition. In order to ensure this a trust is being prepared which will vest the plot in the following trustees:—The Lord-Lieutenant of Oxfordshire, the Vice-Chancellor of the University, the Radcliffe Librarian, the Hope professor of zoology, the Sherardian professor of botany, and the donor. The ground in question is situated at Cothill, near Abingdon, Berks, and is meant more for observation than for collecting purposes. It is hoped that a systematic record, year by year, of a piece of ground untouched by cultivation will be of considerable interest.

AT this moment, when the metropolis is menaced by small-pox, the founding of a league which has for its objects the spread of a wider knowledge of the benefits derived from vaccination and a better understanding among the general public of the advantages arising from preventive medicine and practical sanitation, cannot but be deemed opportune. The Vaccination League has, we understand, the support of Mr. Jonathan Hutchinson, Sir Alfred Garrod, Prof. Charles Stewart and many other medical men.

A GREAT landslip has occurred in Barbados, of the extent, it is said, of 500 acres. The Boscobel district plantations and buildings have been wrecked, eighty-five houses have been swept into the sea, and 400 people are homeless. Roads have disappeared and all the landmarks are gone.

THE *Athenæum* gives the following particulars respecting the new meteorological station which has just been established at Achariach, in Glen Nevis. The situation is such that a spur of Ben Nevis shuts in the valley to the west, and the height above sea-level is only 165 feet. The intention of the founder of the station—Mr. R. C. Mossman, of Edinburgh—is "to study the thermal conditions in the valley and on the adjacent hillsides during anticyclones in winter." It seems that in calm, cold weather and with a high barometer it not seldom happens that the mountain summits are much warmer than the valleys, which are filled with cold air chilled by radiation from the surrounding hills. The height to which this lake of cold air extends is to be the principal subject of investigation. The station is well equipped with a complete set of the best instruments.

IN addressing the Liverpool Chamber of Commerce on Monday last, Major Ronald Ross gave an encouraging account of the progress in sanitary matters which is taking place in West Africa. The governors of the coast were, he said, doing everything in their power for the great cause of sanitation, and their efforts were supported by the Colonial Office, but this sudden and delightful reform was due principally to the action of the Liverpool School of Tropical Medicine. He was still convinced that for practical purposes as a rule drainage was the proper way of dealing with malaria in large towns. In spite of letters in the papers, the fact that mosquitoes carried malaria was an absolute one. They did not propose to destroy every mosquito throughout the continent of Africa, but to reduce them in towns by getting rid of the innumerable breeding places. From six years' special study of mosquitoes he assured them that this measure would have the desired effect. Apart from malaria they proposed to do everything in their power to improve the health of the West Coast in every way. Already they had opened with the British Bank of West Africa a tropical sanitation fund, and they would begin a campaign in Nigeria when they were able to open an account for that work. In his opinion the West Coast of Africa was not so unhealthy as it had been painted by some, and his own experience proved that those who lived carefully there would most likely succeed in avoiding severe diseases. The country was opening up every day, and as it opened up so would disease tend to diminish, as it did in India and Burma before the advance of civilisation.

THE Nordenskjöld South Polar Expedition left Gothenburg on the 16th inst. on board the *Antarctic*.

DR. D. MORRIS, the Imperial Commissioner o. Agriculture for the West Indies, who has been in London for the past few weeks, has now returned to Barbados.

At the recently held annual meeting of the Royal College of Surgeons, Edinburgh, the following prizes were awarded:—The Victoria Jubilee Lister prize of the value of 100*l*., founded by the late Dr. R. H. Gunning "for the greatest benefit done to practical surgery by any Fellow or Licentiate of the College during the quadrennial period ending June 20, 1901," to F. Mitchell Caird, of Edinburgh; the Surgical Essay prize of 100 guineas, offered by the College for "an original unpublished essay on surgery, in any of its branches on anatomy, physiology, therapeutics, or pathology, in their relations to surgery," to J. Veitch Paterson, of Edinburgh, the title of whose essay was "The Lymph Flow through the Eyeball."

THE Lecture List Calendar of the London Institution for the coming session is now ready, and includes the following addresses:—"On the Senses and Intelligence of Animals," by Lord Avebury; "The Life Period of Mountains," by Prof. G. A. J. Cole; "Optical Properties of Diamonds and Rubies," by Prof. S. P. Thompson; "Nourishment and Protection of the Young of some Animals," by Prof. C. Stewart; "Photographic Study of Clouds," by Mr. A. W. Clayden; "Conveyance of Malaria by the Mosquito," by Dr. P. Manson; "Recent Work among the Mollusca," by Prof. G. B. Howes; "The Heart," by Dr. H. Power; "The Mammoth Cave of Kentucky," by Mr. F. Lambert; "The Development of the Human Brain as an Organ of Mind," by Dr. F. W. Mott; "Colour Vision," by Mr. G. J. Burch; "Protection by Shape and Colour in Amphibia and Reptiles," by Dr. H. F. Gadow; "Inert Gases of the Atmosphere," by Prof. W. Ramsay.

ACCORDING to the daily papers a new principle in wireless signalling has been discovered by Mr. A. Orling and Mr. T. Armstrong, who last Friday gave a demonstration of the system which they have worked out. So far as we know, no description of Messrs. Orling and Armstrong's method has as yet appeared in the technical Press, and the details given by the newspapers being somewhat scanty it is difficult to form any definite idea of the probable utility of the system. We gather that the inventors rely partly, if not entirely, on earth conduction, and that they have been successful in transmitting speech in this manner. By using relays buried in the earth the range of signalling has been increased up to two and a half miles overland, a distance which, it must be admitted, is insignificant compared with Mr. Marconi's results. The system is, however, said to offer great facilities for tuning and thus to avoid the interference of messages, an advantage which should be of great benefit to it. The inventors appear to have devoted most of their attention to working out a method of controlling torpedoes or submarine boats from the shore. It may be recollected that in 1899 an account of some experiments made by Messrs. Jamieson and Trotter with this object appeared in the technical papers. These inventors used Hertz waves acting on a coherer on board the torpedo; although at the time it was said that the apparatus worked without a hitch, we have not since heard of its development or practical adoption. Messrs. Orling and Armstrong are said to have successfully guided a torpedo at a distance of six miles from shore.

AN excerpt from the *Proceedings* of the Royal Geographical Society of Australasia (Queensland) contains an illustration of the recently instituted "Thomson Foundation Gold Medal" of the Society. The medal, which is the work of Wyon, is to be awarded annually, or at such times as the council may approve, to the author of the best original contribution to geographical literature, preferential consideration being given to the geography of Australasia, provided it be, in the opinion of the council, of sufficient merit. The subject of the competition for the award of 1902 is "The Pastoral Industry of Australia, Past, Present and Probable Future," and essays must reach the Society not later than June 15 next.

AT the meeting of the Institution of Mining and Metallurgy held on Thursday last, an interesting paper was read by Mr. C. J. Alford on "Gold Mining in Egypt," in the course o. which he said that the exposure of the crystalline rocks in which the ancient gold mines of Egypt were worked, and in which search for deposits of metalliferous minerals might be undertaken with prospects of success, commenced about Jebel Zeit, at the south end of the Gulf of Suez, and extended in varying width along the coast line of the Red Sea, with few and slight interruptions for 700 miles, until it joined the mountains of Abyssinia. At Um Rus the mountain chain of crystalline rocks was about 60 miles in width from east to west, whilst 100 miles south it decreases to about 30 miles; then, in latitude 22° N., the boundary line between Egypt and the Sudan, it extended from the coast westward for fully 200 miles, and, with occasional covers of sand, all the way to the Nile. During the last twelve months the work of exploring the country and the ancient mines had been pushed on energetically. At Um Rus the exploration of one of the ancient gold mines was commenced last December, and so far the results had been decidedly encouraging. Speaking at the meeting at which Mr. Alford's paper was read, Lord Harris stated his willingness to undertake the responsibility that a gold medal, or whatever material object the council of the Institution might suggest, should be presented as a prize for the purpose they might think most useful.

According to the *Electrician*, difficulty has for some time past been experienced in maintaining communication with the observatory on the Zugspitze mountain, 3000 metres high, on the Austrian frontier of Bavaria, throughout the year. Last September the Bavarian Postal Telegraph Administration put the matter into the hands of the Allgemeine Elektricitäts Gesellschaft, who have now solved the difficulty by establishing a wireless telegraph installation between the observatory and the post-office of Eibsee on the Slaby-Arco system. The difference in altitude between the summit of the mountain and the Eibsee post office is 2000 metres. In designing the apparatus such a wave-length was chosen, so that deflection from the surfaces of rocks, &c., on the mountain should assist rather than impede the transmission of the signals. Another difficulty which has been overcome is that of the power supplied to the apparatus. The transport of heavy batteries, &c., to the top of the mountain would have been extremely difficult, and therefore the company has designed the apparatus so that it should require a minimum of power, and the dry cells which are employed with it have proved sufficient. Instead of the wire which has been used in many recent Slaby-Arco experiments, ordinary steel rope has been employed, and this has been fixed in a slanting direction to the surface of the rocks without the assistance of either a mast or insulators. It is stated that the system has so far given entire satisfaction to the Post Office authorities.

At the Trinidad Agricultural Exhibition specimens of sponges which had been collected on the beach of Tobago were on show. The sponges were not large, but were soft in texture, minutely porous, and the presence of large silicious spicules, so common in inferior kinds, was not apparent. They resembled very much what are sold as face sponges. In the specimens exhibited it was seen that the structure was tender and easily pulled to pieces, showing that they would not last long in use. It was explained, however, that the specimens were taken from the beach, and there was nothing to show how long they had been exposed to the rolling of the breakers, the heat of the sun, and the erosion of sand and pebbles of the beach, which would naturally tend to rot the texture of a sponge. Such, however, is the quality that it is thought, says the *Bulletin of Miscellaneous Information* (Trinidad), a trial might usefully be made by a skilled diver on the reefs where they are produced, to ascertain whether the quality would be of fair market value, if harvested direct from their habitat. Such an experiment would cost but little, and, if successful, would confer a blessing on the little Island of Tobago, so long hampered by financial difficulties. In the Bahamas the export for 1898 was valued at 97,512*l*. If the reefs of Tobago should prove as fertile of marketable sponges as those of the Bahamas, it would mean the establishment of a new and permanent industry of the highest value.

The Essex County Council is to be congratulated on the good work done in the technical laboratory at Chelmsford by Messrs. Dymond and Hughes. The "Notes on Agricultural Analyses" just issued contain a careful account of different descriptions of soil occurring in Essex, their geological and physical characteristics, and their chemical composition. This is just the kind of work which county councils may carry out with great advantage.

The annual report of the Connecticut Agricultural Experiment Station, just issued, furnishes a good example of the kind of work done at an American station. One half the volume consists of reports of the analyses of fertilisers, foods and other agricultural commodities; the other half deals with investigations, and discusses agricultural questions. One of the most interesting articles is on the kinds of trees most suitable for street avenues, and the diseases and accidents to which they are specially liable. Dr. T. B. Osborne continues his laborious researches upon the chemistry of vegetable proteids. A valuable bibliography of American work on plant diseases is supplied by Dr. Sturgis.

We have received a copy of Sir Charles Todd's Report upon the Rainfall in South Australia and the Northern Territory during 1898. Monthly and yearly values are given for a large number of stations and show that, generally speaking, the small annual average over the northern districts is mostly made up of summer rains, while in the southern districts the winter rains are largely in excess. As wheat growing chiefly depends upon the latter conditions, the monthly tables are very valuable for agricultural purposes. The annual distribution is clearly shown in two maps which accompany the report.

Mr. W. W. Wagstaffe, B.A., has printed an interesting little pamphlet on the climate and weather of Sevenoaks, based on observations for ten years (1890-99). The absolute maximum temperature was 89° in August 1893, and the lowest 5° in February of the severe winter 1894–5. The average annual rainfall is 29·75 inches, of which only about one-third fell during the daytime. The summer temperature is nearly 3° lower than London.

The first volume of the *Journal of Hygiene* has just been completed by the issue of part iv., which maintains the high standard of its predecessors. In it Rogers discusses the seasonal prevalence of *Anopheles* and malarial fever in Bengal, and his observations support the view that the disease known as Kala-azar of Assam, the ætiology of which has been doubtful, is an epidemic malarial fever and is transmitted by *Anopheles*. Nuttall and Shipley conclude their studies on the structure and biology of *Anopheles*, their paper being illustrated by some excellent plates. Cobbett surveys the epidemiology and bacteriology of a recent outbreak of diphtheria at Cambridge, and Fulton that of the Elkton (Maryland) milk epidemic of typhoid fever. The use of "neutral red" as a test for the colon bacillus and of its presence in waters is the subject of the remaining two papers by Makgill and by Savage. These two investigators, working independently and separately, arrive at practically the same conclusions. They find that this reagent is a very delicate indicator for the colon bacillus and that a negative neutral-red reaction obtained with a sample of a water is high presumptive evidence of the absence of this organism.

The current number of the *Berichte* of the German Chemical Society is remarkable for the number of original communications it contains, there being no less than 106, occupying 753 pages. Among these is a paper by Dr. Otto Ruff, on the existence of ammonium. It has been regarded as highly probable by many experimenters that on treating ammonium chloride solution with sodium amalgam or on electrolysing a solution of ammonium chloride with mercury as kathode, a real amalgam of ammonium with mercury is the true primary product. The problem is here attacked from a new and ingenious point of view, although with negative results. It is known that the alkali metals dissolve in liquid ammonia with the production of compounds possessing a fine blue colour. Thus a solution of potassium iodide in liquid ammonia submitted to electrolysis at a temperature of −70° C.

readily gives this blue compound at the negative pole. A solution of ammonium iodide in liquid ammonia was now substituted for the potassium salt, and then electrolysed at $-95°$ C., but no blue coloration was produced, hydrogen gas being steadily evolved from the commencement of the experiment. Thinking that perhaps an increase of pressure might have the desired effect the tube was sealed up, but although in one case the pressure rose to as much as 60 atmospheres before the tube burst, there was still not the slightest evidence of the existence of the radical ammonium in the free state.

THE same number of the *Berichte* contains an interesting paper, by H. Biltz, on the dissociation of the sulphur molecule. In recent years it has been shown by numerous researches that the maximum density of sulphur vapour corresponds to a molecule S_8 and not S_6 as usually represented in the text-books. But although this point is now well established, there was still a doubt as to the exact manner in which the molecule dissociated, the results of the first measurements of Biltz suggesting that the dissociation actually took place in two stages, the molecules S_8 first breaking up into S_6 and S_2, and these S_6 molecules finally splitting up into $3S_2$ molecules. In order to set this point at rest further measurements were carried out, the results of which are given in the present paper. The problem can be attacked in two ways; the densities can be determined at constant pressure, or at constant temperature with varying pressures. The latter method, giving isotherms, was selected as being capable of the greater accuracy, experiments being carried out at a temperature of 444° C. and at pressures between 14 and 540 mm. of mercury. The author concludes that only two kinds of sulphur molecules exist, S_8 and S_2, the former being the only ones present in sulphur solutions, the latter in sulphur gas at temperatures above 850° C.

A REPORT has been drawn up for the Franklin Institute on recent advances in the physics of water, by Dr. George Flowers Strading, and is published in the *Journal* of the Institute for October (pp. 257–269). It deals with the theory which assigns to water a complex molecular constitution, the maximum density and its dependence on the pressure, the relations between the pressure, volume and temperature, and the viscosity. In connection with the molecular constitution of water, the author discusses at some length Röntgen's theory, which regards water as consisting of two kinds of molecules called "ice molecules" and "molecules of the second kind." A subject somewhat allied to the above, namely the freezing points of solutions, was recently dealt with in the *Physical Review* by Messrs. E. H. Loomis and W. F. Magie.

THE *Mathematical Gazette* contains a brief account of the recent "Teaching of Mathematics" discussion by Mr. R. F. Muirhead, and a paper on the slide-rule by Prof. F. R. Barrell. We should like to see more matter of this kind in the pages of the *Gazette*, which, it may be remembered, is the organ of an association which till recently called itself the Association for the Improvement of Geometrical Teaching. The present is an opportune time for the Association to resume the functions expressed by its old title, and the fact that many of the members are engaged in teaching mathematics on conventional lines would add to the value of any opinions expressed in the *Gazette*.

IN a note contributed to the Lombardy *Rendiconti*, xxxiv. 16, Signor Alberto Dina compares the hysteresis in iron under a rotating, an alternating, and a statical magnetic field. In the first the magnitude of the inducing force remains constant and its direction varies, in the second and third the direction remains constant while the magnitude varies. The third case is distinguished from the first and second by the property that the complete cycle takes place much more slowly. The present experiments differ from those previously made in that the same body has been used in measuring each of the three kinds of hysteresis. The table of results shows clearly the behaviour of these different forms of hysteresis for equal induction; while the "alternating hysteresis" is always greater than the "statical hysteresis," the "rotatory hysteresis" lies between both of them until $B = 10,000$ units approximately; it then becomes equal to the statical, and afterwards less, and both the percentage difference and the absolute difference increase as the induction increases. These experiments were performed with iron of low permeability, and it is suggested that similar experiments with soft iron might yield interesting results.

IN addition to papers dealing with meteorological and physical subjects, Nos. 1 and 2 of the *Bulletin* of the Moscow Society of Naturalists for 1901 contain an important article by J. J. Gerassimow on the influence of the nucleus on the growth of the cell, and also one by Prof. D. Sernoff on the morphological nature of the tail-like appendages occasionally met with in the human race. After describing, with illustrations, several examples of these appendages, the latter author comes to the conclusion that they are teratological and in no sense atavistic.

IN the *Biologisches Centralblatt* for October, Dr. G. von Linden commences an account of his investigations into the structure of wings of insects, especially the Lepidoptera during the pupal stage, in relation to their origin and their bearing on the phylogeny of the different groups. The subject has been taken up where it was left by Schäfer, van Bemmelen, Haase, Urech and Eimer, and the theory of the latter that the original type of coloration in Lepidoptera was in the form of longitudinal stripes, while a uniform coloration is the final development, is confirmed. The bearing of the investigation on classification is left for a later communication.

IN the *Victorian Naturalist* for September Mr. W. Macgillivray concludes his notice of North Queensland birds, while Mr. R. Hall gives a further instalment of his notes on undescribed nests and eggs of Australian birds.

WE have received a copy of a paper by Miss N. Evans on the habits of the common grey mosquito of Calcutta (*Culex fatigans*), published in the August issue of the *Proceedings* of the Asiatic Society of Bengal. It is shown that the adult female may live for about five weeks, during which it may feed five times, when it selects by preference the blood of the house-sparrow. The latter fact suggests the possibility of this insect being a carrier of a definite blood-infection.

THE additions to the Zoological Society's Gardens during the past week include a Black-headed Lemur (*Lemur brunneus*), a Yellow-cheeked Lemur (*Lemur xanthomystax*) from Madagascar, presented by Mr. S. Neven Du Mont; two Arctic Wolves (*Canis occidentalis*) from New Mexico, presented by Mr. William Ruston; three Shaw's Gerbilles (*Gerbillus shawi*), a Dwarf Jerboa (*Dipodillus campestris*) from North Africa, presented by Mr. J. S. Whitaker; a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, two White-fronted Capuchins (*Cebus albifrons*) from South America, a Green-headed Tanager (*Calliste tricolor*) from South-east Brazil, two Dinca Finches (*Dinca grisea*) from Chili, a South Albemarle Tortoise (*Testudo vicina*) from the Galapagos Islands, a Rough Terrapin (*Nicoria punctularia*) from Northern South America, two Annulated Terrapins (*Nicoria annulata*) from Western South America, two Menobranchs (*Necturus maculatus*) from North America, two Dark Green Snakes (*Zamenis gemonensis*), a Four-lined Snake (*Coluber quatuorlineatus*), European; ten Snake Fishes (*Polypterus senegalus*) from the White Nile, East Africa, deposited; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, eight Golden Plovers (*Charadrius pluvialis*), European, purchased.

OUR ASTRONOMICAL COLUMN.

THE SPECTROSCOPIC BINARY CAPELLA.—The *Lick Observatory Bulletin* No. 6 contains the final values adopted for the orbit of the spectroscopic binary system of Capella. The reductions are from thirty-one observations of the radial velocity of the solar-type component, made with the Mills spectrograph between 1896 September 1 and 1900 September 27. On most of the plates the spectra of the two components are distinguishable, that of the principal star being of the solar type, whereas that of the secondary component is intermediate between the solar and Sirian types. The ranges in velocity are as follow:—

Principal star $+4{\cdot}2$ to $+55{\cdot}7$ kilometres per second.
Secondary ,, -3 ,, $+63$,, ,,

Therefore the ratio of the two masses will be as $1{\cdot}26 : 1$.

The solar-type component is estimated to be about half a magnitude brighter photographically than the blue component, while in the visual region of the spectrum the solar component is probably a whole magnitude the brighter of the two.

In consequence of observations with the 36-inch refractor under good conditions failing to show the duplicity of star, it is probable that the distance between the components is not greater than $0''{\cdot}06$.

The following are the final adopted elements, with their several probable errors:—

$\omega = 117^\circ{\cdot}3 \pm 18^\circ{\cdot}3$.
$\mu = 0{\cdot}060403 \pm 0{\cdot}000014$ radians.
$= 3^\circ{\cdot}46082 \pm 0^\circ{\cdot}00081$.
$T = -17{\cdot}4 \pm 5{\cdot}3$ days, the actual date being 1899 September 1·5.
$e = 0{\cdot}0164 \pm 0{\cdot}0055$.
$K = 25{\cdot}76 \pm 0{\cdot}12$.
$U = 104{\cdot}022$ days $\pm 0{\cdot}024$ days.
$a \sin i = 36{,}847{,}900$ kilometres.
$V = +30{\cdot}17 \pm 0{\cdot}104$ kilometres per second.

NEW SOUTHERN ALGOL-VARIABLE.—Mr. A. W. Roberts announces that observations made at Lovedale confirm the variability of the star,

R.A. = 10h. 16m. 44s. } 1875.
Decl. = $-41^\circ\ 43'{\cdot}8$ }

The observations suggest the following elements:—

Period = 1d. 20h. 30m. 2s.
Epoch of Min. = 1900, Jan. 1d. 15h. 10m. (G.M.T.)
Limits = 10·0–10·9 magnitude.

The actual light changes are completed in 3h. 20m., and there appears to be no stationary period at minimum. The ascending and descending phases are equal, each occupying 1h. 40m. (*Astronomical Journal*, vol. xxii. No. 508.)

SPECTRUM OF NOVA PERSEI.—In the *Astronomische Nachrichten*, Bd. 156, No. 3741, Father Sidgreaves summarises as follows the results of his examination of recent photographs of the spectrum of the Nova Persei:—

All hydrogen lines are now relatively weak, excepting the doubtful line $H\epsilon$.

λ5007 much stronger than $H\beta$ or $H\gamma$. Great width.
4958 prominent broad band.
4718 grown from a weak to strong band.
4713 strong line on edge of 4718.
4688 rather weak broad band.
4640 gradually weakened like hydrogen.
4364 very prominent band, stronger than $H\gamma$, crossed by three bright lines.
3969 ?$H\epsilon$. As strong as all other hydrogen lines together.
3869 stronger than 3969.

All these, with the exception of 4718, which shades off on red side, are broad with sharp edges. The structure of bands 3969 and 3869 very remarkable, being crossed by four strong lines of the same relative intensities and at the same intervals. This is also shown in the line 4364.

MICROMETRIC OBSERVATIONS OF NEPTUNE AND ITS SATELLITE.—In the *Astronomical Journal*, vol. xxii. No. 508, Prof. E. E. Barnard gives a series of micrometer measures of the satellite of Neptune extending over the period 1889 August 12—1901 February 5, made with the 40-inch refractor of the Yerkes Observatory. Many observations had been recorded previously, but it has been pointed out by Prof. Hall that only continuous measures of this object are of value. For the majority of the observations a power of 700 diameters was employed.

On three occasions it was possible to obtain good measures of the diameter of the planet, the reduced value being

$$d = 2''{\cdot}436 \text{ (at mean distance} = 30{\cdot}0551).$$

A note is made of the fact that the planet, when seen under the best conditions, always appeared round and free from markings.

APPEARANCE OF THE PHOTOGRAPHIC IMAGE OF NOVA PERSEI.—MM. Flammarion and Antoniadi contribute a further article respecting the photographic image of Nova Persei to the October issue of the *Bulletin de la Société Astronomique*, which is specially interesting in that it is illustrated by drawings and reproductions from the photographs obtained, showing exactly the appearances presented. These have already been described; the suggested explanation by Dr. Max Wolf ascribing them to the objective not being corrected for some special radiation emitted by the Nova does not appear to have been definitely settled yet, but the great intensity of the ultra-violet lines in its spectrum, together with the fact of the existence of the newly observed line about λ 342, would seem to support this supposition.

RECENT PROGRESS IN WATERWAYS AND MARITIME WORKS.

THE fourteen papers presented to the section of Waterways and Maritime Works at the International Engineering Congress at Glasgow were for the most part descriptive of important recent works carried out in various parts of the world, as, for instance, the Dortmund and Ems Canal, the Assuan Reservoir Dam across the Nile, the improvement of the Lower Mississippi, the Chicago Drainage Canal, the breakwaters for sheltering the entrance to the River Nervion, the Zeebrugge Harbour Works, and recent improvements in the lighting and buoying of the Scottish and French coasts. Some papers, moreover, dealt with the gradual extension and recent progress of works commenced many years ago, as, for example, the improvement of the River Clyde and its estuary and the works of Glasgow Harbour, recent improvements in the navigable condition of the Sulina branch and outlet of the Danube, and the lighting of the Chinese coast.

Some of these works furnish, for the most part, a record of the steady development and extension of methods of execution, constituting in the end a very notable advance, of which, however, the stages have been numerous and gradual; whilst other works present distinctly novel features, exhibiting a very definite progress in engineering science, and therefore of somewhat special interest, as will be briefly indicated.

The lift at Henrichenburg, on the Dortmund and Ems Canal, for raising barges of 950 tons from one reach of the canal to another, 46 feet higher, in a single operation, illustrates the novel principle of supporting the trough, carrying the barge, on several floats immersed in wells; and the whole structure is so perfectly balanced that the introduction of a small quantity of water into the trough at the top causes it to descend, and the abstraction of some water from the trough when at the bottom makes it ascend, the actual transit being effected in two and a half minutes, though the whole operation of transferring a barge from one reach to the other occupies about twelve and a half minutes on the average. This system of simple flotation, in place of the older system of hydraulic lifts, consisting of two counterbalancing troughs, each supported centrally on a hydraulic piston which even for raising barges of from 300 to 400 tons has had to be given a diameter of 6½ feet, has enabled these canal lifts, with their important advantages over locks of saving largely both time and water, to be adopted for vessels of more than double the tonnage of those raised by the older canal lifts.

The large excavations required for the Chicago Drainage Canal led to the adoption of excavators and dredgers of unusual size, the bucket of some dipper dredgers having been given a capacity of six cubic yards; whilst the removal of large masses of earthwork to the sides of the canal trench gave rise to the introduction of novel types of plant. These consisted of cableways suspended from high travelling towers on each side of the canal, along which skips conveyed the earthwork from the excavations to the spoil banks on either side; conveyors forming a bridge stretching across the channel, with cantilever arms projecting over the spoil banks on each side, carrying a steel travelling belt which conveys the material to the depositing ground; cantilever conveyors running on rails along one bank of the trench, with one arm dipping down into the excavations and the other rising over the spoil bank, up which incline a trolley is drawn for disposing of the earthwork; inclined planes leading to a travelling bridge with an open roadway extending over the spoil bank, through which wagons drawn up the incline deposit their load; and, lastly, high-power revolving derricks and other machinery for the rapid and economical removal and deposit of the excavations.

The novelty of the reservoir dam in progress at Assuan across the Nile consists in the one hundred and eighty sluices by which it is pierced affording a waterway of 24,000 square feet, through which the whole flow of the Nile in flood-time will be discharged, amounting to a maximum of 475,000 cubic feet per second with a velocity of 20 feet per second. These openings will be closed for storing up water for summer irrigation, by counterbalanced sluice-gates working on free rollers, which can be readily raised or lowered against a considerable head of water.

The deepening of the navigable channel by about 3½ feet outside the Sulina mouth of the Danube since 1895 by dredging, giving an available depth of 24 feet, shows that it is possible under favourable conditions to cope with the deposits of a minor channel of a deltaic river by means of dredging, at any rate for a time; though it must be anticipated that eventually the accumulations of deposit in front of the mouth will necessitate an extension of the jetties, to enable an improved scour across the advancing delta to aid dredging in the maintenance of the depth of the outlet channel.

The injuries caused during two successive winters to the superstructure on the top of a rubble mound, forming the main breakwater in progress for sheltering the approach to the River Nervion leading to the port of Bilbao, exposed as this breakwater is to the full force of the waves rolling in from the Bay of Biscay during north-westerly gales, has led to the adoption of a novel method of depositing blocks of concrete of unusual size for the purpose of providing a secure foundation for the superstructure in this exposed site, where the breakwater extends into a depth of about 50 feet at low tide. The method comprises the construction of metal caissons to serve as a lining for the blocks, which are ballasted with concrete, floated out into position, and sunk in place by filling them with water, after which they are filled as rapidly as possible with large concrete blocks, and with concrete in mass in the interstices and on the top, so as to constitute a solid block, the largest blocks thus formed at the Bilbao Harbour Works having a weight of about 1500 tons. These blocks, laid in a row on the top of a rubble mound at a depth of about 16½ feet below the lowest low water, within the shelter of the original rubble mound with its capping of large concrete blocks, have proved a perfectly stable foundation for the superstructure which is being erected upon them. This system is being extended at Zeebrugge Harbour in the North Sea, at the entrance to the Bruges Ship Canal, where steel caissons have been constructed and lined with concrete, which are to be floated into position in calm weather one by one for the foundations of sea and harbour walls along each side of a quay, and an outer solid breakwater; and these blocks, when completed, will rest on the sea bottom, and weighing from 2500 tons up to 4400 tons, will emerge about 2½ feet out of water at low water of spring tides, so that a solid superstructure can be readily built upon them.

Remarkable progress has been achieved in recent years in the extension of appliances for the more efficient lighting of minor shoals, outlying reefs, and navigable channels. The ease of rotation obtained by floating the illuminating apparatus on an annular mercury bath, has enabled the system of group flashes, giving a distinctive character to each light, to be extended to beacons exhibiting a continuously burning light for three or four months, by rotating the light apparatus by an electric battery placed in a chamber in the beacon. The increased speed of rotation, moreover, rendered possible by the floating on a mercury bath, has enabled the number of panels of lenses to be reduced and their size increased, and consequently a brighter flash to be exhibited. Various improvements also have been effected in the lights themselves. Thus carbonised wicks have been devised which enable a light to continue burning without being attended to for a considerable period, with only a moderate deterioration in intensity; incandescent lamps have been adopted, fed by oil gas or petroleum vapour, which provide an excellent light; and acetylene is being experimented upon by the French Lighthouse Service, and the danger of explosion having been overcome by using very small tubes for supplying the burner, it appears likely to furnish a very bright, serviceable light. Special attention has been lately devoted to reducing the divergence of the light exhibited by lightships from the vertical, as with a considerable rolling of the vessel in a storm the light is liable to be obscured for a time. As it has been ascertained by observation that the waves in severe storms have a fairly definite period of oscillation in any particular locality, the special period of oscillation of the waves where a lightship is to be placed is ascertained; and the vessel is so designed, and its weights adjusted, that its period of roll may differ materially from the oscillation of the waves at its station; and the roll of the lightship is further checked by giving it a large draught and deep bilge keels. Moreover, the light and its accessories are supported on a sort of compound pendulum, with weights so adjusted at the bottom and above the light that the oscillation of the pendulum differs from the roll of the vessel, and the stability and consequent visibility of the light is thereby increased.

Altogether the papers furnish interesting indications of some of the advances being achieved in the execution of waterways, maritime works, and the lighting of shoals and channels; and the prospect of important extensions of waterways is manifested by the Dortmund and Ems Canal, forming merely the first instalment of a waterway intended to connect most of the rivers of Prussia, and the proposal of a Russian engineer for constructing a deep waterway to connect the White Sea and the Baltic, capable of being traversed by large seagoing vessels.

ITALIAN GEOLOGY.[1]

AN elaborate memoir, containing results of a study of the rocks and geology of the basin of the Sesia with the exception of its lower portion, the Strona valley and the western portion of the Orta lake, has lately been issued. The authors remark that, having made traverses of this region in several directions, noting many stratigraphical details, they were obliged to recognise the impossibility of the task of determining the "absolute chronological value" of the different formations. Neither does their microscopic examination of the rocks help them more to unravel the stratigraphical problems. This is a result which is not infrequent where petrographical methods are treated as paramount. Petrography, as I have frequently laid stress upon, is but *an aid* to geology, a valuable one, I admit, but inferior to good and accurate field-work, lithology, and a wide general knowledge of the surrounding region, and especially of the habits in other regions of the same class of rocks.

The authors have, as they but too justly point out, to contend with the absence of any known fossiliferous horizon, or in fact any stratigraphical standard formation as a datum to work from. In addition a large mass of volcanics traverse the Valsesia between the two principal crystalline formations and produce uncertainty in the limits of each, further disturbing the already complex stratigraphical arrangement and masking the relations of one to the other. At the commencement of the paper is a bibliographical list of fifty-three memoirs dealing with the locality in question.

It was found convenient for the petrographical studies to divide the rocks of the higher basin of the Sesia into five groups:—

(1) Gneiss of Strona (with an appendix on the granites).
(2) Massive augitic and hornblendic rocks.
(3) Gneiss of Sesia (including the schists of Rimella and Fobello).
(4) Greenstones (pietre verde) properly so called.
(5) Gneiss of Monte Rosa.

The authors deserve much credit for not venturing beyond the old nomenclature of Gerlach and Parona, the earlier students of this region.

Under the first group are included mica-schists with silli-

1 "Ricerche Petrografiche e Geologiche sulla Valsesia," by E. Artini and G. Melzi (*Mem. del R. Istituto Lombardo di Sc. e Lett.*, vol. xvii. pp. 219–392; pl. xxii.).

manite, gneisses, biotitic granular, with two micas, scaly with microcline, fine grained biotitic, nodular amphibolic, dioritic, augito-hornblendic and fine-grained tormaliniferous; augitic granulites, amphibolites, olivine and serpentiniferous rock and calciphyres (*i.e.* crystalline calcitic rocks containing more or less various silicates). In the appendix is included an examination of the granitites of Roccapietra, Quarna, and some vein granites.

The second group comprises diorites—micaceous, augitic and hornblendic; norites—simple and with hornblende; gabbros—simple and with garnet and with olivine; peridotites, pyroxenites and hornblendites are represented by lherzolites, harzburghites and websterites. The banded gabbros and stronalites are represented by banded augitic gabbros, banded hornblendic gabbros, stronalites. Basic dyke rocks, as spessartites, amphibolites and dioritic schists, are each given their share of microscopic researches. Some interesting observations are offered concerning the occurrence of schistose structure in these rocks.

Under group three are included light-coloured schistose gneisses, mica-schists and prasinitic rocks. A notable fact in this formation is the presence of thick bands and big masses of truly massive granitoid rocks intercalated between the more schistose kinds. These are of different types in which the characteristic element may be microcline, quartz, or of the type

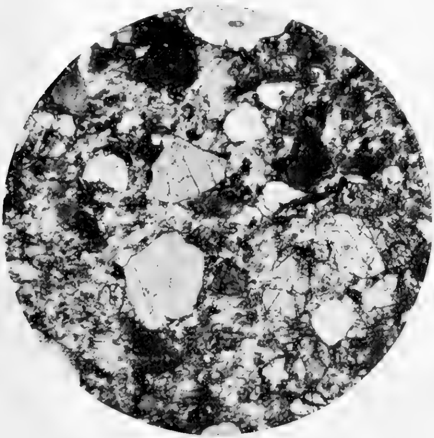


Fig. 1.—Calcifiro a Wernerite, con struttura clasticoporfirica.

of an augite-horneblende diorite. Though not attaining any notable development, still the nodular or *eyed* gneisses are interstratified with the other rocks of this formation, especially at Valle de Carcoforo and other localities.

Another member of this group which owes its structure to dynamic metamorphism is the finely-banded gneisses in the Val Grande. The structure of the limestones, calciphyres and schists of Rimella and Forbello are each carefully described.

The fourth group, included under the name of greenstones (pietre verde), though of less importance from the point of view of mass, present undoubtedly the most varied characters, such as prasinites, amphibolites, amphibolic schists, eclogites, serpentine, and oliviniferous rocks, calc-schists and saccharoidal limestones, garnetiferous mica-schists, and light-coloured gneisses and quartzite schists.

The final or fifth group, or gneisses of Monte Rosa, are remarkable for their uniformity of composition. The variations seem to consist chiefly of a porphyroidal, schistose, banded or tubular structure, passing by gradations to microgneisses and mica-schists.

The petrographical description of this large number of divers rocks and their varieties is very detailed, and appears to be done with much care. It is, of course, quite impossible to give even in outline a review of this in the space at our disposal. A clearer idea of the varied rock-structures is afforded by the large number of admirable photo-micrographs which the authors have executed themselves, and which are extremely well reproduced in the twenty plates devoted to this part of the subject.

The second section of the memoir is devoted to the geological characters of the rocks. Unfortunately, the authors are able to add little that is new, or add any facts of general interest. Observations of dip are recorded, as well as contact-phenomena between rocks of divers mineralogical and chemical composition. These physico-chemical effects seem to be most variable—highly developed at one spot, and hardly to be remarked at others; no attempt, however, is made to explain these variations.

The authors deny the absence of contact effects, as asserted by Schaefer and Salomon, and between the basic eruptive rocks and the gneiss of Strona, and give some striking examples. As to the basic eruptive rocks, the authors show they are posterior to the Strona gneiss, and discuss their relative age to the Sesia gneiss. The other groups are treated rather from the point of view of their petrographical characters than from their geological aspect.

Cleavage and foliation, the effects of dynamo-metamorphic processes, is well developed in one part of the region, and quite absent in another; but few details of the types of foliation,

Fig. 2.—Prasinite Cloritica, struttura microocellare.

and other changes, are offered the reader. The difference o interpretation of the relative ages and relations of the Strona and Sesia gneisses, with Parona, is fully portrayed in a tabular form of Messrs. Artini and Melzi's views.

The greenstones of this region the authors collegate, and even consider to be identical, with the greenstones of the Western Alps, lately pronounced by the *Comitato Geologico* to be Triassic and Liassic; whilst the gneiss of Monte Rosa they consider as Palæozoic or even Archaic.

A good geological map in colours of the region under consideration is given, and another coloured plate is devoted to sections. This work represents a great deal of patient labour in a difficult region, and, altogether, the authors are to be congratulated on their work. A little more charity to their opponents might here and there be allowed. It might also suggest itself to their mind that Germany does not hold a monopoly of petrographical research; that in France, and even in poor little England—not to speak of America, Norway, and other countries—many problems that are concerned in this memoir have been tackled, the published results of which might afford them some additional information.

H. J. Johnston-Lavis.

THE FUMIGATION OF FRUIT TREES.

THE systematic way in which fruit crops are protected from insect pests and other natural dangers in California has often been mentioned in these columns. Among the enemies of citrus plants are scale insects, or bark lice, and mites, to the consideration of which an article, by Mr. C. L. Marlatt, is given in the U.S. Year Book of Agriculture for 1900. The natural predaceous enemies of scale insects are various species of ladybirds, such as the Australian ladybird, which was introduced into California to control the fluted and black scales. The black

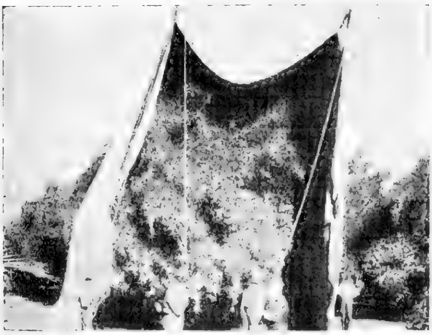


FIG. 1.—Tent carried over tree by the falling of pulleys.

scale has been completely controlled on certain ranches in the United States by its ladybird enemy, and this control has been brought about by the entire cessation of all insecticide operations. But until this condition of things exists on all the ranches, or at least until the natural enemies of scale insects have been fully studied, it is necessary to depend upon spraying and fumigation to keep down the insect pests. The most effective means of doing this is by subjecting infected plants to the fumes of hydrocyanic acid gas. The treatment consists in enclosing a tree at night with a tent as shown in the accompanying illustrations, and filling the tent with the poisonous fumes generated by treating refined potassium cyanide (98 per cent. strength) with commercial sulphuric acid (66 per cent.) and water. The treatment is particularly successful in getting rid

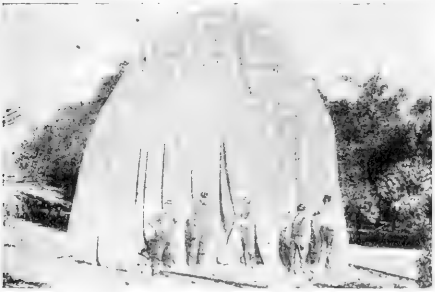


FIG. 2.—Tent in position for fumigation.

of the black scale (*Lecanium oleae*, Bernard) and California red scale (*Aspidiotus aurantii*, Maskell). The tents under which the trees are fumigated are drawn over the trees by means of pulleys, and some of them have diameters of more than seventy feet. To the fruit-grower who leaves things to chance, the work involved in the manipulation of such a protective process may appear excessive, but the cost must be regarded as insurance against loss due to defective crops, and the results obtained in California show that the expenditure of money and energy is fully justified.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MRS. ANNA HOUGH has offered 40,000 dollars to the University of Southern California at Los Angeles on condition that the balance of 100,000 dollars be raised. The University recently obtained from Mrs. Hough the sum of 25,000 dollars on like conditions.

DR. JAMES MUSGROVE, formerly lecturer in anatomy, was on Wednesday, the 16th inst., installed in the chair of anatomy endowed by the late Marquis of Bute, and instituted under the recent new ordinances in connection with the University of St. Andrews.

UNIVERSITY fellowships, each of the value of 100*l.*, have been awarded at the Victoria University, Manchester, to Drs. E. N. Cunliffe (Owens College) and G. W. Gelderd (University College), both of whom are undertaking research work during the coming year.

IN the expectation of further considerable grants by the local counties authorities, the council of the Birmingham University has, it is understood, authorised the Buildings Committee to prepare plans and specifications for necessary buildings, estimated to cost, without equipment and furniture, the sum of 200,000*l.*

THE following appointments are noted in *Science*:—Dr. J. B. Overton to be professor of biology, Dr. J. H. Hall, assistant professor of physics, each at Illinois College, Jacksonville, Ill., U.S.A., and Mr. F. B. Littell, of the U.S. Naval observatory, has been appointed to a professorship of mathematics in the U.S. Navy.

DR. J. BISHOP TINGLE, instructor of chemistry at the Lewis Institute, Chicago, formerly lecturer in chemistry at Gordon's College, Aberdeen, and at the Merchant Venturers' Technical College, Bristol, has been appointed professor and head of the newly organised department of chemistry at the Illinois College, Jacksonville, Ill., U.S.A.

THE new Municipal Technical College at Sunderland has started with the enrolment of 600 students. This number so largely exceeds the reckoning of the Technical Education Committee that the Borough Council, in order to provide for the necessary increase of the staff, will, it is expected, be compelled to have recourse to its rating powers.

THE dedication of the Severance Chemical Laboratory of Oberlin College took place on September 26, when an address was given by President Ira Remsen, of the Johns Hopkins University. In the course of the proceedings it was stated that Mr. Lewis Severance, the donor of the laboratory, had given the sum of 40,000 dollars as an endowment for the chair of chemistry.

AT a recent meeting of the governors of the Durham University College of Science, Newcastle, the principal of the College submitted his report, in which he stated that the fund for the completion of the College buildings amounted to 31,000*l.* The suggestion of their treasurer, Dr. Hodgkin, that a suitable memorial to Lord Armstrong would be to erect a statue upon some prominent site, and to dedicate the College to his memory, had received the hearty support of Mr. Watson-Armstrong, and was cordially adopted by the council. They resolved to ask the University to consent to a change of name, and to invite subscriptions to an Armstrong memorial fund. A public meeting was held, resolutions were adopted approving of the scheme, and upwards of 20,000*l.* was promised towards it.

SPEAKING at a meeting held on Wednesday, the 16th inst., to inaugurate the third winter session of the London School of Tropical Medicine, Dr. Manson said that the school wished to fulfil two functions, viz., the education of the practitioner who proposed to devote his life to practice in the tropics, and the attempt to advance medical science as regarded tropical disease. How far they had been able to fulfil those undertakings it was for those present to say. As regarded the educational part of their work he could claim that they had had a distinct success although they began with a certain amount of trepidation and anxiety. They had succeeded in overcoming financial difficulties and professional opposition, the first mainly through the assistance and countenance of Mr. Chamberlain and also with the assistance of the managers of the Dreadnought Hospital. From the first their student attendance was a fair one; but session after session the numbers of students asking for admission had increased, and now the applications were much more numerous than the accommodation they had to offer would allow them to admit. The mere physical space at their disposal was not sufficient to accommodate those who came to study there, and their appeal that day had for its object the removal of that obstacle to their success. The accommodation must be doubled if the school work was to go on. They wanted their laboratories very much enlarged; they wanted a lecture room, a room for a museum, and a good library. All these things were very necessary if the school was to go on and prosper. The work which the students of the school were doing warranted him in appealing for funds on its behalf. As instances of such work Dr. Manson referred to the investigation conducted by Dr. George Low in the West Indies respecting elephantiasis, the work of Dr. Durham and Dr. Myers in Brazil last year, and the new expedition of Dr. Durham to Christmas Island. The English Government, said the speaker, was very niggardly in regard to such matters compared with the German Government. Prof. Koch had forwarded to him, at his request, the following particulars of the subsidies granted to investigators working in connection with medical expeditions sent out under the auspices of the German Government:—"(1) Prof. Frosch in Brioni (Istria), (2) Staff-doctor Bludau in Lussinpiccolo (Istria), (3) Staff-doctor Vagedes in German South-West Africa, (4) Staff-doctor Dempwolff in New Guinea, (5) Staff-doctor Ollwig in German East Africa, (6) Dr. Krulle in the Marshall Islands. Further expeditions to Togo and Kameruns are being planned. The expeditions 1 to 5 have for their collective object, in the first place, the investigation of malaria, and form regular continuations of any malaria expeditions made to Italy, Dutch India, and New Guinea. Expedition No. 6 has for its object the investigation of syphilis and its different forms in the South Sea Island groups. The European expeditions 1 and 2 receive 20 marks (1*l.*) daily allowance, besides compensation for the various travelling expenses, outlay for the laboratory, &c. The "outside Europe" (foreign) expeditions receive 40 marks (2*l.*) daily, besides compensation for travelling expenses and outlay for scientific objects (books, instruments, complete laboratory arrangements, their upkeep, &c.), with a further 1000 marks (50*l.*) for personal equipment." The treatment thus accorded to German scientific expeditions was very much more generous than anything done for similar expeditions in this country, and he trusted that the school would receive generous accessions to its funds.

IN distributing the prizes at the Royal Technical Institute, Salford, on Friday last, Sir Henry Roscoe said it had often puzzled him to account for the singular apathy with regard to education which in times past, and to some extent even now, had characterised the average Englishman. Surely one would think that he of all men, dependent as he was for his very existence on his successful solution of problems relating to industry and commerce, would have felt it not merely an advantage, but an absolute necessity, that his knowledge and training should be as perfect and widespread as possible, just because the arts and trades which he practised had their foundation in artistic or scientific principles, and could only flourish satisfactorily under the guidance of those principles—that was, under educated effort. Whilst other countries—notably Scotland, Germany, the United States, Switzerland and France—long ago established their national system of schools, England up to 1870 was without one. Whilst Italy, Scotland, Germany and France in earliest times founded Universities which had remained as Universities of and for the people, the older Universities of Oxford and Cambridge had gradually become mainly high schools for privileged persons, and ceased to do for England what the Scottish Universities did for Scotland—that was, to be the Universities for all classes of the population, rich and poor alike. It must be the aim of the reorganised University of London to do for London's six or seven millions what the Scottish Universities had done for four millions of Scotsmen, and to become a real University for the people. England, however, was awakening. A new era in the history of English education began, first, in the foundation of the local University colleges, and, secondly, in 1890, in the passing of the Local Taxation (Customs and Excise) Act. The fact of the allocation of a sum of upwards of 750,000*l.* to technical and secondary education was an event unparalleled in the financial history of this country, and was in itself a proof of this awakening. That this act of the Government was appreciated was shown by the fact that the local authorities generally at once availed themselves of the opportunities thus presented. No less than upwards of 3,000,000*l.* had been expended by municipal and local authorities in providing technical schools throughout the land. Moreover, this progress had been unchecked by reverses or by waning interest; on the contrary, it had been continuous, universal and rapid. Still, much remained to be done. "Organise your secondary education" had been the cry from Matthew Arnold's day to our own. Yet nothing had been done in this direction by Parliament, with whom the duty lay. It was true that beginnings had been made; local authorities in some instances—and here he must name those of Manchester—had taken the matter into their own hands and had realised how necessary it was to consolidate and coordinate the education of various kinds existing in their midst, and actually had done so in advance of national action. The country had, he thought, made up its mind and would back any sensible plan for putting this part of our educational house in order. Let them unite in urging immediate action. Let them be satisfied with one thing at a time. If they saw that to put forward and to carry a measure which would bring about that which all desired—namely, that the various forms of educational effort should be organised as one compact whole—was at the present moment beyond the range of practical politics, let them not fail to secure the organisation of a part. This seemed to him to be common sense.

ON Tuesday last Mr. R. B. Haldane, K.C., M.P., delivered an address at University College, Liverpool, on "The Function of a University in a Commercial City," in the course of which he compared the position of education in this country with that in others, notably in Germany. Throughout the industrial world of Germany they found science applied to practical undertakings by men who had learned, if not in the Universities and high technical schools, at least under teachers produced by those institutions. This was true of a multitude of trades. In electrical engineering, in the manufacture of chemicals, in the production of glass and of iron and steel, and of many other articles for which Britain used to be the industrial centre, we were rapidly being left behind. A striking case was that of the aniline colours discovered and first produced in England and manufactured out of English coal tar. The industry had almost wholly shifted to Germany, although the dyers in this country were the largest consumers. The reason for this was that in Germany the manufacture had been fostered by research in the University laboratories and by careful teaching in the technical schools, with the result that great producing institutions, such as the Badische Anilin Fabrik, had an endless supply of directors and workmen trained in a fashion which we had not the means to imitate. But the school was in Germany by no means the only point at which the professor came to the aid of industry. Too little was known in this country of the type of institution sometimes called the "Central-Stelle," which had no parallel among our business men. This establishment, which was maintained by subscription at a cost of about 12,000*l.* a year, was presided over by one of the most distinguished professors of chemistry in the University of that city, with a staff of highly-trained assistants. To it were referred as they arose the problems by which the subscribers in their individual work were confronted. By it was carried on a regular system of research in the field of production of explosives, the fruits of which were communicated to the subscribers. The great manufacturers were in constant communication with the establishment, in which they took the keenest interest. In this country, it was needless to say, there existed nothing of the kind. And yet we had to compete with the Germans, not only at home, but in such important markets for explosives as South Africa, where their use was the life of the huge mining industry. Proceeding, Mr. Haldane alluded to the German academic institutions and compared them with the University system of this country, and made a number of suggestions which, if carried out, would, in his opinion, tend towards a better system of education and be for the benefit of the country. The conclusion of the whole matter, said Mr. Haldane, seemed to be that we could establish in Great Britain and Ireland a system of teaching of a University type, with the double aim of the system of Germany, and that without injury to quality in culture.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, October 1.—Mr. Charles Bailey, president, in the chair.—Mr. W. E. Hoyle exhibited two ethnological specimens from Demerara, formerly in the possession of the Manchester Natural History Society, under the name of "fish-arrows." They are about 4 feet long, slender, and apparently made from the wall of some hollow reed, with nodes at regular intervals. At one end is a barbed point of wrought iron, the other end being stained a dark brown for about four inches. The use of these weapons is somewhat difficult to determine; they are too thin and flexible either to shoot from a bow or to throw with true aim. Instruments of a similar kind have, however, been used for catching fish by baiting the barbed end and sticking the other end into the bed of the stream among the reeds.—Mr. Cecil P. Hurst sent specimens of *Diotis candidissima*, Desf., a disappearing British plant, which he collected recently on the sandy bars separating two inland lakes from the sea on the south-eastern coast of county Wexford, Ireland. He described its habitat on the shores of Lady's Island Lake and Tacumsin Lake, and on the coast from Carnsore Point westward, and referred to its recorded occurrence in nine of the comital areas in the South of England, from all of which, including the Channel Islands, it has disappeared. It was found very sparingly on the south-western coast of Anglesey in the years 1894 and 1896.

PARIS.

Academy of Sciences, October 14.—M. Bouquet de la Grye in the chair.—New series of experiments relating to the action of hydrogen peroxide solution upon silver oxide, by M. Berthelot. A thermochemical comparison of the action of acids upon oxide of silver before and after the action of hydrogen peroxide. The results are regarded as proving conclusively that a peroxide of silver is formed in this reaction, and that the evolution of oxygen is due to the decomposition of this compound.—On the variation of races and species, by M. Armand Gautier. Experiments by Molliard, and by Charabot and Ebray, on the influence exerted by the attack of certain insects on the development of certain plants, and the researches of Daniel on grafting, are held by the author to prove that the Darwinian principles of the influence of medium, of adaptation and of natural selection are insufficient to explain the profound and rapid modifications which have here taken place.—Two new hæmogregarians of fishes, by MM. A. Laveran and F. Mesnil. A detailed description of two new parasites of the sole and blenny, to which the names *Haemogregarina bigemina* and *Haemogregarina Simondi* are given. The paper is illustrated with seventeen drawings of the parasites in various stages of development.—The influence of variations of temperature on the evolution of experimental tuberculosis, by MM. Lannelongue, Achard and Gaillard. Neither a moderate degree of cold nor slight variations of temperature have any marked influence upon the development of experimental tuberculosis in guinea-pigs. On the other hand, brusque variations of temperature, although compatible with the life of healthy guinea-pigs, have accelerated in a remarkable manner the course of the disease.—On waves which may persist in a viscous fluid, by M. P. Duhem.—The elliptic element of the comet 1900*c*, by M. Perrotin. Measurements of the position of this comet, which was discovered by Giacobini on February 11, have been made in the observatories of Nice, Lick, Besancon, Algiers, Heidelburg and Strasburg, and show that it belongs to the curious group of periodic comets supposed to have been captured by Jupiter. The return of this comet may be expected in about seven years.—On the periodic integrals of binomial differential equations, by M. A. Davidoglou.—On the points of inversion of solutions, by M. Albert Colson. It is known that the specific heat of a solution is not the mean of the specific heat of its constituents, and hence it follows that the heat of solution and the heat of combination are variable, and at a fixed temperature some heats of solution change their sign. For solutions of common salt this point of inversion is found to be at 52° C.—The action of urea upon pyruvic acid. Homoallantoic acid and pyruvil, by M. L. J. Simon. It is shown that in this reaction, which has been previously studied by Grimaux, there is an intermediate compound formed, homoallantoic acid, and that the formation of pyruvil is due to an internal condensation of this compound.—The nitro-derivative of pentaerythrite, by MM. Leo Vignon and F. Gerin. The pentaerythrite, $C(CH_2OH)_4$, was prepared by the interaction of aldehyde, formaldehyde and lime water, and was found to possess no reducing power towards Fehling's reagent. The nitric ester was prepared and found to be the tetra-derivative; it was devoid of reducing power, and hence it is probable that the nitric esters which do possess reducing power have a constitution which is different from that usually ascribed to them.—On the free phase of the evolutive cycle of the orthonectides, by MM. F. Caullery and F. Mesnil.—Marine poisons and the burrowing habit, by M. G. Bohn. It has been found that sea-water in which certain red algæ have been growing is very poisonous, but that it loses this poisonous property on filtering through sand. Burrowing animals have thus the double advantage of mechanical and chemical protection.—On the eruptive rocks of Tilai-Kamen (Ural), by MM. L. Duparc and F. Pearce.—On a green colouring matter extracted from the blood of animals poisoned by phenylhydrazine, by M. Louis Lewin. The green substance, for which the name of hemoverdine is proposed, is not apparently a phenylhydrazine derivative, but a product of metamorphosis of hæmoglobin.—The spectrum of this substance is absolutely different from that of hæmoglobin or of any of its known transformation products.—The microphyte of the Piedra, by M. P. S. de Magalhaes.—On the mechanism of the formation of fine pearls in *Mytilus edulis*, by M. Raphael Dubois.

DIARY OF SOCIETIES.

SATURDAY, OCTOBER 26.

ESSEX FIELD CLUB (Essex Museum of Natural History, Stratford), at 6.30.—Mimetic Insects: Prof. R. Meldola, F.R.S. (Illustrated by Natural Colour Photographs.)

THURSDAY, OCTOBER 31.

CHEMICAL SOCIETY, at 8.30.—The Frankland Memorial Lecture: Prof. H. E. Armstrong, F.R.S.

FRIDAY, NOVEMBER 1.

GEOLOGISTS' ASSOCIATION, at 8.—A Conversazione in the Library of University College, Gower Street.

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THURSDAY, OCTOBER 31, 1901.

PTERODACTYLES.

Dragons of the Air: an Account of Extinct Flying Reptiles. By H. G. Seeley. Pp. xiii + 239. Illustrated. (London: Methuen and Co., 1901.) Price 6*s*.

EVER since the study of fossil remains was taken up in earnest, pterodactyles, or, as the author elects often to call them, ornithosaurs, have attracted the deepest attention on the part of anatomists on account of the many puzzling problems connected with their organisation and affinities, while from their weird form, peculiar attributes, and the huge dimensions attained by some of their later representatives they have appealed more strongly to popular interest than is the case with many of their extinct contemporaries. Among all the diligent students of the organisation of these strange creatures (so far as it can be worked out from their bones alone) none has been more constant or more persistent than Prof. H. G. Seeley, who commenced his investigations when a student at Cambridge during the late 'sixties. At that time the so-called coprolite-works in the Cambridge Greensand were in full swing; and the rich, albeit much broken, material thus obtained afforded opportunities for studying the structural details of pterodactyle bones in a manner impossible when dealing with the embedded skeletons of the smaller forms from the lithographic limestone of the Continent. Of these opportunities—both as regards study and collecting—Prof. Seeley availed himself to the full; and from that time to this, as occasion presented itself, he has, we believe, continued faithful to his favourite study. During the latter years of Prof. Sedgwick's tenure of the Woodwardian Chair at Cambridge, Prof. Seeley delivered a series of lectures at various centres—including the Royal Institution—on pterodactyles; and the present volume purports to be a reissue of these lectures in an expanded form, with such revision as has been rendered advisable by the progress of investigation.

In this volume Prof. Seeley appeals, as he tells us in the preface, alike to the general public and to the man of science. To achieve success in this double *rôle* is by no means an easy matter; and it may be questioned whether he has not given too much elementary explanation to suit the latter class of readers and not enough for the needs of the former. This, however, is a matter which concerns an author and his publisher rather than a reviewer.

All who have been occupied in investigating the osteology of pterodactyles can scarcely fail to be struck with the marked similarity presented in many respects—especially in the skull and cervical vertebræ—to birds. And this avian resemblance seems to have impressed itself with peculiar force on the mind of the author, who has all along contended that these creatures are not entitled to be ranked as reptiles, but form an outstanding group by themselves, displaying very widespread affinities with other groups of animals. So widespread, indeed, does Prof. Seeley regard the relationships of pterodactyles that it is by no means an easy matter to understand what his opinions on this subject really are, especially as his sentences are not unfrequently so involved that it is difficult to grasp his meaning. Even, however, if they cannot agree with them (or in some cases even understand them), the views of such an experienced and earnest investigator on a subject he has made specially his own should command respectful attention on the part of those whose knowledge in this respect is less extensive than that of the author.

Perhaps the best way of endeavouring to convey an idea of the author's views on pterodactyle relationship—which is the leading feature of the book—will be to quote his own words.

Selecting a few passages in serial order, we find it stated on p. 58 that[1]—

"While these animals are incontestably nearer to birds than to any other animals in their plan of organisation, thus far no proof has been found that they are birds, or can be included in the same division of vertebrate life with feathered animals."

On p. 188 we are told that—

"It is not so much that they mark a transition from reptile to bird, as that they are a group which is parallel to birds, and more manifestly *holds an intermediate place than birds do between reptiles and mammals*."

Again, on p. 210 we find the following:—

"Therefore there is a closer fundamental resemblance between some carnivorous dinosaurs [*e.g. Coelurus*] *than might have been anticipated*."

On the following page it is stated that—

"The dinosaurs, like pterodactyles, must be regarded as *intermediate* in some respects *between reptiles and birds*."

Finally, on p. 223, we have the following:—

"It would therefore appear from the vital community of structures with birds, that pterodactyles and birds *are two parallel groups*, which may be regarded *as ancient divergent forks* of the same branch of animal life, which became distinguished from each other by acquiring the different condition of the skin, and the structures which were developed in consequence of the bony skeleton ministering in different ways; and with different habit of terrestrial progression, this extinct group of animals acquired some modifications of the skeleton which birds have not shown. There is nothing to suggest that pterodactyles are a branch from birds, but their relation to birds is much closer, so far as the skeleton goes, than is their relation with the flightless dinosaurs, with which birds and pterodactyles have many characters in common."

Other passages might be quoted, but the foregoing are sufficient to indicate the extreme complexity of pterodactyle relationship according to the author. Personally we must confess to a total incapacity to draw a mental picture of the relationships thus indicated; and we have also failed in the attempt to construct a diagram which will show how groups that are divergent are yet parallel.

We have also yet to learn that birds are in any respect intermediate between reptiles and mammals; while we totally fail to see how any animals can be, *even in some respects*, intermediate between reptiles and mammals on the one hand, and reptiles and birds on the other. That is to say, in the sense in which we understand the term "intermediate," as indicative of descent.

[1] The italics introduced into these quotations are the reviewer's.

Again, as suggestive of prejudice, we must take the strongest exception to the author's use of the expression "than might have been anticipated" in connection with the affinities between pterodactyles and dinosaurs. What right had anybody to form "anticipations"?

If the author really intends to imply that birds and pterodactyles are divergent and specialised branches from groups of reptiles which cannot yet be identified (at all events in the latter case) with any approach to certainty, we can agree with him. But this by no means implies any intimate relationship between the two branches in question, the structure of the limbs of which is alone amply sufficient, in our opinion, to demonstrate their totally different origin. In urging an affinity between birds and pterodactyles, Prof. Seeley, in addition to the (may we say superficial ?) resemblances between their skulls and brains, lays stress on the fact that both have pneumatic bones. This feature is taken as an indication that pterodactyles probably possessed warm blood, from which is drawn the further inference that they were also furnished with a four-chambered heart. Even if the first inference be well founded, the second by no means follows, the author himself quoting the fact that the blood of the tunny has a temperature of 90°. And even if pterodactyles were warm-blooded and furnished with an avian type of heart, we should be none the more inclined to admit their affinity with birds.

Apparently the author takes no account of similar modes of life leading to the development of superficially similar bodily structure in totally different groups of animals, and the consequent "convergent" resemblance between them. And if this be so, his premises are so widely different from those on which the investigations of others are based that it is little wonder irreconcilable diversity of view results.

An instance of this nature occurs on p. 219, where we find the statement that "a few characters of ornithosaurs are regarded as having been *acquired*, because they are not found in any other animals, or have been developed only in a portion of the group." In one sense all characters are acquired; but the use which the author makes of the term "acquired characters" does not correspond with its ordinary scientific acceptation. From this we may perhaps infer that in other instances the signification attached to terms is different from that usually in vogue—which would account for much.

It is not, however, solely in regard to the affinities of these reptiles, as we still take leave to call them, that the author differs so much from current views. He likewise attributes to pterodactyles a bodily form quite unlike that with which they are generally credited; and one, it may be said, which makes them the most grotesque and bizarre creatures that ever walked this earth. But could they walk at all, as thus restored? is a question which can scarcely fail to occur to those who look on these wonderful pictures. In most or all other restorations, as in the plate by Smit in Hutchinson's "Extinct Monsters," pterodactyles, when not flying, are shown crawling on rocks or cliffs, or sitting up on their hind legs on some prominence preparatory to taking flight. Prof. Seeley will, however, have nothing to say to such crouching attitudes, and represents the creatures standing on all fours, with the greatly elongated wing-finger bent back alongside the fore-arm and projecting above the hind-quarters, and the wing folded like an inverted Chinese sun-shade. Whether such slender hind-limbs as are shown in the restoration are capable of supporting the weight of the body in this position we will not pause to inquire. Our difficulty is in connection with the fore-limb, the raising of which would apparently cause the wings to strike against the ground at every step, even if they did not become entangled with the hind-legs. Moreover, the creature is represented as actually standing on the joint between the metacarpus and the wing-finger, and as this joint must certainly have been a highly delicate and complex structure, it appears impossible to conceive how it could have escaped injury in walking if carried in the position shown in the restoration. Possibly the author has an explanation of these difficulties, but if so it would have been more satisfactory had it been given to the public.

To revert, in conclusion, to the main argument of the book, we fully realise the amount of labour that Prof. Seeley has expended on a very difficult subject, and at the same time are prepared to admit the advantage which often accrues to the progress of science from the presentation of opinions widely different from those generally entertained. Nevertheless, we scarcely think that he will persuade those of his readers whose verdict is worth having to agree with him in regarding pterodactyles and birds as in any way near akin, or will convince them that the former creatures are no longer entitled to be classed as reptiles. Aberrant they are, no doubt, but not so much so as, in our opinion, to be excluded from the limits of a class comprehensive enough to embrace such diverse types as dinosaurs, turtles, ichthyosaurs and snakes. As to the alleged relationship between the "dragons of the air" and the egg-laying mammals, we are fain to confess that it requires a greater power of imagination to realise the nature of the affinity than it falls to our own lot to possess.

R. L.

ELEMENTARY DYNAMICS.

Theoretical Mechanics: an Elementary Treatise. By W. Woolsey Johnson, Professor of Mathematics, U.S. Naval Academy. Pp. xv+434. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1901.) Price 3 dollars net.

THE author states in his preface that "the study of mechanics is here supposed to follow an adequate course in the differential and integral calculus." Hence it is difficult to see how it can appeal to any class of students—at least in this country—especially as, in addition to both branches of the calculus, the conceptions of geometry of three dimensions are also introduced at the outset. The student who has already progressed thus far in mathematics does not require to be introduced to the parallelogram of forces and all the elements of the composition and resolution of coplanar forces and velocities. There is nothing distinctively novel in the work, which is, on the whole, a careful compilation from the works of the best writers on the subject, without any acknowledgment of the sources.

The first two chapters deal with forces acting on a particle, and make free use of the calculus and geometry of three dimensions. In chapter iii. the author settles down to the composition, resolution, and equilibrium of a general system of coplanar forces, and gives a very good exposition of the subject; but in this chapter, of nearly fifty pages, no use of either the calculus or three-dimensional geometry is made, except in three pages devoted to the common catenary. Now the understanding of this very important and extensive section of dynamics is well within the power of any student even if he is quite ignorant of these branches of pure mathematics, so that it seems a pity that he should be kept back in his dynamical studies until he has passed through "an adequate course in the differential and integral calculus."

Passing over chapters devoted to the determination of centres of gravity and the composition of forces which are not coplanar, we come to chapter vii., which treats of the principle of work. This chapter is somewhat meagre, consisting mainly of what is known as "book-work," and not containing sufficient illustration of the applications of the principle to concrete cases. Until the student comes to chapter viii. he will experience no difficulty in the author's treatment of the subject; but when he reaches this chapter, on "motion produced by constant force," he will find a good deal about the nature of "inertia regarded as a force" which will be very perplexing. His main difficulty will be to decide whether the author means the "force of inertia" to be one exerted *by* a body or *upon* it by some agent or medium. Thus, at the beginning of art. 288 it would appear to be a force exerted *by* the body:—

"The property of matter through which *it resists* any change of motion, in accordance with the First Law of Motion, is called Inertia."

But a few lines farther on we have the sentence:—

"Now, just as the resistance of a fixed body in contact with that upon which the force acts, and preventing its motion, is regarded as a force equal and opposite to the force which would otherwise produce motion, so the resistance to motion in the body when free is regarded as a force equal and opposite to the active force which produces the motion."

Let us suppose a particle M acted upon by forces whose resultant is P and kept from moving by the resistance, N, of a fixed surface B; then the force N is exactly equal and opposite to the force P. Again, imagine the body M acted upon by the same force P and unresisted by any fixed surface; M will have an acceleration a, and the statement is that there is acting on M a force resisting the acceleration a—this force being clearly produced by something which in our thoughts replaces the above fixed surface B—that this force is equal and opposite to "the active force which produces the motion." So far, what this "active force" is is not clear; but the next sentence defines it:—

"Thus the force of inertia acts upon a particle of mass m only when there is an acceleration a, and its value is ma, while its direction is opposite to that of the acceleration."

Now observe that if the particle had no acceleration, this force would be zero, while in the first part of the analogy (where also $a = 0$) the supposed analogous force, N (the resistance of the surface B) is not zero.

However, from this and from subsequent statements it is clear that, in the author's view, a force of inertia really acts on a particle m which has an acceleration a, and that this force is scalarly and vectorly equal to $-ma$; that is to say, it is D'Alembert's fictitious "reversed effective moving force." But this is not in accordance with the statement at the top of p. 288:—

"And the inertia which acts upwards is, at that point, simply the resistance of the body to being moved away from the tangent at O."

It is certainly strange that a force acting *on* a body should be the resistance of the body to being moved. The author, however, clearly defines his conception, which he calls that of "kinetic equilibrium," at the top of p. 244:—

"For example, suppose a man whose weight is W to be standing on the floor of an elevator which begins to descend with the known acceleration a. The forces acting on the man are his weight, $W = mg$, acting downward, his inertia, ma, acting upward because the acceleration is downward, and the resistance R of the floor of the elevator acting upward. Since the forces are all vertical, there is but one condition of equilibrium, namely, $W = R + ma$."

The objection which a student will raise to this is that if the man is really acted upon by the upward force ma, the man is really at rest and not in motion at all.

D'Alembert never attributed anything but a fictitious existence to his "reversed effective forces," and he was right and consistent all through. The real objection to his principle is that it teaches us to be dissatisfied with the actuality (viz. motion), and to seek refuge in a fiction (viz. rest). The teaching of Newton's second axiom is quite different: it accepts motion as a fact and deals with it.

The remainder of the book gives somewhat short and easily readable discussions of central orbits, motion (especially uniplanar) of rigid bodies, moments of inertia, and impulses.

OUR BOOK SHELF.

The Earliest Inhabitants of Abydos; a Craniological Study. By D. Randall-Maciver. Plates viii + tables 16. (Oxford: Clarendon Press, 1901.) Price 10*s*. 6*d*. net.

IN the present work Mr. Randall-Maciver presents to the public the craniological material which he obtained in Upper Egypt in the winter of 1899-1900, and the results which he has deduced from it. In a series of eight plates he gives us photographs of a large number of skulls which he obtained from two cemeteries at Abydos, which, he says, belonged to the earliest and the latest stages of the pre-dynastic period, and to these he adds some sixteen tables of minute craniological measurements. The first cemetery contained only pottery of the earliest forms, black-topped, polished red, and white ornamented red, and the second degraded wavy-handled vases and other pottery of well-defined classes. The remarks which Mr. Randall-Maciver makes in his short preface may be regarded as a continuation of those expressed in his "Libyan Notes," and we observe that he still holds the view that the theory of the Libyan origin of the pre-dynastic or proto-dynastic Egyptians is "based on wholly inadequate evidence." The pre-dynastic Egyptians were, he thinks, a mixed race, but as a whole that race was not Berber; on the other hand, he does not deny the existence of an original Berber substratum, though he believes that its existence requires to be proved. A question of the kind must be decided by "expert anthropologists," for "archæology has its own place, and should recognise its own limitations; it can prove connections of culture, but not identities of race." We can only hope that the archæologists who hold different views from those of Mr. Randall-Maciver will take these observations to heart and turn from the error of their ways. It is, we must confess, a little disconcerting to find such a strictly scientific authority as Mr. Randall-Maciver reduced to suggesting that "it is well worth considering whether the pre-dynastic race of Egypt is not in the main a blending in various proportions of Semite and Negro." It is much to be hoped that his promised work on the whole subject will clear up some of its difficulties, but it seems doubtful, judging by the work of Mr. Randall-Maciver and Prof. Sergi, whether the archæologist will obtain much useful help from the craniologist.

The New Basis of Geography. A Manual for the Preparation of the Teacher. By Jacques W. Redway. Pp. xvi+226. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1901.) Price 4*s*. 6*d*. net.

NOT that the basis is really "new," for the author, who is perhaps the most successful writer of geographical school-books in the English tongue, knows a great deal better. In his preface he says in effect that the novelty of his basis is only apparent to the ignorance of the average teachers, and the newer they find it the more shame to them. "This book," he explains, "is intended to set forth in an elementary manner the relations between human activities and geographic environment." It does so very well. The style is facile and free, permeated by an air of genial familiarity with the subject, and with the class of reader appealed to. There is a tendency to semi-epigrammatic sentences, shattered fragments of which will be recognisable in the breccia of the pupil-teacher's examination papers for a generation to come:—"War has its horrors, but it is less horrible than ignorance." "Accuracy is the one virtue that cannot possibly belong to a flat map." "It is not necessary to worry about the plane of the ecliptic."

The last proposition will probably be popular, if one may say so without disrespect to other "imaginary lines."

Mr. Redway has produced a thoroughly practical, well-informed and thoughtful book; one which can not only be read with pleasure by the teacher in the study, but practised with profit in the school. True, it does not accord with any of the "codes" in this country, but the principles it lays down will be found perfectly amenable to any pattern of red-tape harness. Stress is laid on the superiority of the method of teaching by letting the pupil discover his own facts—"The reading method might fit a young man to be a private secretary; the discovery method fits him to be the employer of private secretaries."

References to books are given as well as hints on method, and Mr. Redway is generous in commending the works of other writers. We feel sure that his strongly practical exposition of the nature and value of geographical principles will do more to promote sound geographical education than any amount of learned advocacy by theorists can ever accomplish.

Expertises et Arbitrages. By F. Rigaud. Pp. 177. (Paris: Gauthier-Villars. Masson and Co., 1901.)

IN this volume, which belongs to the Encyclopédie scientifique des Aide-Mémoire series, the author gives a *précis* of standard legal works on reports and arbitrations, and summarises the principles and laws which should be considered by arbitrators and experts more familiar with technical knowledge than law. From this practical point of view the book may prove of service.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Note on a Point of Chemical Nomenclature.

SENIER AND GOODWIN have, in a recent paper (*Journ.* Chem. Soc. vol. lxxix. p. 258), made use of the term "alphyl" as a generic name for the aromatic radicles. The continued use of this term with the meaning attached to it by the above authors is one which may lead to some confusion. It is undoubtedly of advantage to be able to distinguish by special names fatty from aromatic radicles. With this end in view Bamberger proposed some time ago (*Berichte*, xxvii. 2583) "*alphyl*" as a general term for aromatic radicles, such as phenyl, tolyl, &c. He derived this word from "alkyl-phenyl," and as it supplied a want it was speedily adopted by investigators and appeared in scientific papers and text-books. Vorländer in 1899 (*Jour. für praktische Chemie*, lix. 247) drew attention to the possibility of error centred in the new name. As he remarked, every student of chemistry on hearing the word "alphyl" for the first time would think, not of an aromatic compound, but of one belonging to the fatty or aliphatic division. He then pointed out that *alphyl* was, on the contrary, a thoroughly suitable name for a monovalent hydrocarbon radicle of the fatty series, and that an aromatic radicle might be designated by "*arryl*."

For monovalent fatty radicles we have the name "*alkyl*" suggested years ago by J. Wislicenus and derived from "alcohol." There is no reason for superseding that term, but its meaning might with advantage be enlarged. Vorländer's proposal was that *all* monovalent hydrocarbon radicles, whether fatty or aromatic, should be called "*alkyl*" groups, this term being in opposition to "*acyl*" used by Liebermann (*Berichte*, xxi. 3372) for acid-radicles. We may then subdivide the alkyl group into fatty and aromatic divisions, giving each a special name.

The following scheme sets forth the proposed nomenclature:—

I. *Alkyl.* All monovalent hydrocarbon radicles.
(*a*) *Alphyl.* Aliphatic radicles (CH_3, C_2H_5, &c.)
(*b*) *Arryl.* Aromatic radicles (C_6H_5, &c.)
(*c*) *Alpharryl.* Aromatic radicles possessed o. a fatty character (benzyl, &c.)

II. *Acyl.* Acid radicles in general ($CH_3.CO$, $C_6H_5CH_2CO$).

Bamberger, the proposer of the term "alphyl" for aromatic radicles, acknowledged the ambiguity and adopted Vorländer's proposal (*Lieb. Ann.* cccv. 289). One modification he suggested, and this was the change from "arryl" to "aryl." Since that time he has used in all his work the term "aryl" where he previously used "alphyl." This is a custom which now generally obtains in Germany, and "alphyl" in its original sense has almost altogether disappeared from papers and text-books. Should now the term "alphyl" be used in England for an aromatic radicle, it will creep again into such reference periodicals as the *Centralblatt* and there occur side by side with "alphyl" and "aryl" in their later meanings, as has already been the case, and this will lead to manifest lack of clearness and confusion. Some English chemists use "aryl" for an aromatic radicle (*cf.* Sudborough, on acetylation of arylamines, *Proc.* Chem. Soc. xvii. p. 45). It would therefore be of great advantage to agree on a uniform use of these different terms.

A. T. DE M.

Folklore about Stonehenge.

I REMEMBER, when I was a child, between seventy and eighty years ago, being told that the stones could be successfully counted only by laying a loaf of bread beside each. To mark each stone by something to prevent one being missed or counted twice over seems natural; but why a loaf of bread? Is this an idea surviving from the "*cultus lapidum*" referred to in your review of "Carnac and Stonehenge" in NATURE of September 12? I think it probable that I had this from a nursery-maid who came from Mere in Wiltshire, and who had a taste for the marvellous.

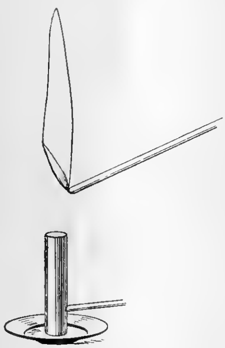
O. FISHER.

Harlton, Cambridge, October 19.

A Curious Flame.

THE following experiment with a Bunsen flame may interest some of your readers.

A Bunsen burner is lighted below and turned down so that the escaping gases will no longer burn at the upper end of the tube. The end of a glass rod is placed in the stream of gas and a lighted taper applied to it. The gas now burns steadily and the flame takes the form of a finger-stall attached by one point to the rod. A little adjustment of the gas supply may be required. A glass tube filled with water will not serve, which suggests that the rod must have a temperature of more than 100° C. Wires of any common metal may be used instead of the glass rod. It is a beautiful experiment.



The above came under my notice about six months ago when experimenting with flames, and I can find no reference to it in any book or journal. Perhaps some of your readers can give me information.

L. L. GARBUTT.

Winchester College, October 20.

THE LONDON FOG INQUIRY.

THE action of the County Council of London in devoting a sum of money for the purpose of aiding the Meteorological Council in making an inquiry into the occurrence and distribution of fogs in the London district has attracted public attention to an undertaking which is in itself of a very unambitious character. The discomforts and dangers of a London fog are indeed a loud challenge to the scientific and practical intelligence of Londoners, but what is aimed at in the present case is not any heroic attempt to deliver London from its insidious enemy, but the collection of information as to the best mode of attacking the purely meteorological question of local forecasts. In the language of the hour, it is a scouting expedition and not an attack in force.

Whether such a preliminary inquiry will of itself yield results that are either novel or valuable is still to some extent a matter of opinion. It originated in a request from the electric lighting authorities of several districts to be supplied, for obvious reasons, with forecasts or warnings from the Meteorological Office of the probable occurrence of serious fogs. Very much is already known about fogs. Apart from the special investigations of Dr. Russell and others, the students of weather maps are quite familiar with the general meteorological conditions under which fogs are likely, and recognise even more easily the conditions when they are unlikely. Besides this more or less technical knowledge, there is a large and increasing store of experience of fogs amongst the millions of dwellers in the London district. From recent circumstances I am able to say that he who would select an abode in London can obtain much curious information on the subject from friends, scientific and otherwise. It may take the form of testimony as to the relative prevalence of fog in other people's localities or its intolerable prevalence in his own, according to the temperament of the witness. It must, perhaps, be allowed that it is a rash undertaking to controvert the statement that the phenomena of London's fogs are well known.

Yet when one is brought face to face with the practical question, "Can you give us an hour's warning of the approach of a fog in any particular district?" one is driven to realise that, after all, the abundant knowledge based on the prolonged experience of many observers lacks coordination. If conditions are favourable for the occurrence of fog, which part of London will be the first to experience it? and at what rate will it spread or move to other parts? and where will it be most dense? Will it begin on the river and gradually extend to the heights, as a sea fog pours over the land? or will the heights first cover themselves with mist rolling down to the valleys? or if some locality is specially favoured as compared with others, by what numerical or percentage estimate should the advantage be estimated?

Statistical answers to these questions are clearly within reach. One year's experience will give no final statistical results, but it may at least give an indication of the possibility and prospect of obtaining such results. Some preliminary understanding must be arrived at as to the method of describing the experience of the different observers. There are fogs of many colours and of diverse character and density; some are on the surface, others, which do not come so low even as the tops of buildings, produce at noonday the darkness of night. It may be assumed that these differences of type, as well as differences of distribution, are not entirely capricious, but are related to some specific difference in the meteorological conditions, general or local, the local topography and conditions of the surface, or the local geology. All these things can also be ascertained, but whether the differences are sufficiently marked as to be recognisable in individual cases and to form a basis for forecast work is a question which, with all deference to the opinion of those who regard the phenomena of fogs as known, is worthy of investigation. Nor is it even easy, when one considers the difficulty of securing uniformity of convention among observers and uniformity of exposure of thermometers and other instruments. It is a question that requires to be approached, if confusion is to be avoided, with the intelligence of trained scientific scepticism.

The County Council, while authorising the organisation of observations at the fire stations by the staff of the fire brigade and possibly at other institutions under the control of the Council, have assigned to the Meteorological Office the responsibility for the conduct of the investigation and for providing all necessary instruments. The Office is also expected to make arrangements for observations outside the administrative County of London. The organisation of the details of such cooperation is not without its difficulties, but the cordiality with which the County Council has expressed its desire to cooperate is a weighty element in favour of the success of the attempt. It is obvious that without such cooperation the organisation of an efficient system of volunteer observations would be a matter of great labour and prolonged delay.

I have been careful to indicate the limitation of the immediate scope of the present inquiry to the collation of local observations of fog, and perhaps of temperature of air and water, with other local data and the general meteorological conditions. This is mainly a matter of appropriate organisation. There are, however, some physical aspects of the formation of vapour in the atmosphere which may be of service as a guide to the classification of the conditions of distribution of fog. In the forefront I would place the question as to what is the source of supply of the water which is the main constituent of those fogs which are not simply wreaths of smoke. Does the water come from the ground on which the fog lies? or the air in contact with it? or from some higher or more distant region? It is a matter of common observation that a surface of relatively hot water covers itself with drifting clouds of so-called steam. There are doubtless surface fogs which correspond to this condition, though when the evaporation is very rapid there may be, as Mr. C. T. R. Wilson has shown, a clear layer immediately in contact with the water surface. Fogs which have their origin in this mixture of the rising vapour with cooler air may be called "steaming water fogs." On the other hand, if any surface is sufficiently cold the absorption of heat from the air in contact with it may cause condensation in the air close to the surface, and fogs arising in this way may be called, for the sake of brevity, "cold-surface fogs." Vigorous radiation such as takes place on a clear night from grass may cause a fog of this character, and in regard to the persistence of a fog under these circumstances the transparency, or rather translucence, of fog for radiation is an important but not well-known factor. In these cases the source of the water supply is easily identified as being the water surface in the one case and the air in contact with the surface in the other.

Clouds, consisting of more or less detached masses of fog formed in either of these two ways, may drift like the steam from a locomotive or a sea fog over land, and a fog may thus visit a locality which has had no share in supplying the water. There is, moreover, another possibility which may be connected with the question as to why fogs are more prevalent in winter than in summer, in spite of the fact that the store of moisture in the air is larger and changes of temperature are more pronounced in the warmer months. Rain has been defined as a falling cloud which reaches the surface before the evaporation of the globules is complete. The rate of fall depends on the size of the particles, but in still atmosphere even the smallest particles make their way downward. In summer the falling cloud may consist of anything between a thunder shower and drizzling rain. In winter, when the supply of moisture is less and, over towns, the supply of nuclei for condensation is greater, the counterpart of the summer drizzle may be so light as to be classed as fog or mist, and fall with extreme slowness. In this case the water supply comes from strata above the surface. There are certainly some fogs in which there seems to be a gradual deposit of moisture on horizontal surfaces, and not merely on specially cold surfaces. It is true that winter fogs are often associated with high barometric pressure, generally a fine weather association, but under similar conditions of pressure very light rainfalls on our eastern and northern coasts are sometimes experienced. Whether electrical conditions, which are exceptional in foggy weather, may account for the formation or accelerate the falling of the cloud in such circumstances I cannot say.

If we call this third form of fog, due either to the surface drifting or the downward descent of a cloud formed above the surface, a "cloud fog," we have altogether three forms—"steaming water fogs," "cold-surface fogs" and "cloud fogs." It is evident that, of these three, two depend upon local conditions which may possibly be identified, while the third is at least much more independent of local conditions and its incidence may be as capricious as the summer cloud.

The consideration of the observations from this point of view requires more than mere organisation. It involves a special knowledge of the physics of the atmosphere applied to observations of a somewhat special kind, and may need some appropriate apparatus. It is hoped that circumstances will allow the statistical investigation to be combined with the consideration of such physical questions as those which I have indicated; but the time for arrangement is short, and it is possible that the physical side of the investigation may have to wait for a more favourable opportunity. The primary consideration at present is the suitable organisation of trustworthy observations.

W. N. SHAW.

ALUMINIUM AND ITS USES.

THE number of metals available in large quantities for industrial purposes is so very small, that the successful introduction of a new one must be of the greatest interest. The affinity of aluminium for oxygen much exceeds that of iron at a red heat. Iron oxide is reduced by carbon at that temperature, while alumina cannot be reduced in this way except in the electric arc. And thus, though the ores of aluminium are more widely distributed even than those of iron, yet the former metal remained for long unknown, and until lately was comparatively rare.

About fifty years ago, the researches of Wöhler and Deville led to the latter's process for the production of aluminium on a commercial scale, in which the vapour of aluminium chloride was led over heated sodium. The price of the new metal fell rapidly, but was always high and dependent upon that of sodium.

In 1854, Bunsen and Deville showed independently that aluminium could be obtained by electrolysis from a bath containing the chlorides of both aluminium and sodium in a state of fusion, the latter chloride acting merely as a flux. But at that time the cost of electrical energy was prohibitive.

The first successful electrical process was that of Cowles, in which alumina is reduced by carbon in the electric furnace. It rapidly superseded the old chemical method, in spite of the reduction in the price of sodium by the Castner process, but had soon in its turn to give place to the processes of Hall and Héroult discovered in 1886 (though not successfully worked until some years later). In these, a bath of the fused fluorides of aluminium and sodium is employed. They occur naturally combined as cryolite; and serve, when melted, as a solvent for alumina, which by itself would, of course, be almost infusible. The alumina is electrolysed by a current introduced at a carbon anode, and further alumina is added as the metal collects at the other pole. The bath must be maintained at a red heat, and an electromotive force of somewhere about five volts is needed.

It is this process which has brought down the cost of aluminium so much of late. Other methods, as those of Blackmore and Gooch, depending upon the preparation and subsequent electrolysis of fused aluminium sulphide, are said to be yet more economical, the sulphide being much more readily decomposed than the oxide. But the saving in electrical energy does not yet seem to make up for the greater expense of working materials.

The cost of water-power, even in situations offering great natural advantages, cannot be indefinitely reduced, owing to the great capital outlay needed for hydraulic works. There is, then, little doubt that the present cost of aluminium, about eighteenpence a pound, represents roughly the lowest figure at which the Hall and Héroult processes can profitably be worked. With a density 30 per cent., and a conductivity 60 per cent. that of copper, pure aluminium conductors can transmit the same electrical energy over a given distance with only half the weight of metal. As an electrical conductor, therefore, aluminium at eighteenpence is equivalent to copper at ninepence a pound, or 84*l*. a ton, a figure considerably below what it lately reached.

It is curious to observe how entirely dependent the electrical engineering industry is upon the price and the conductivity of copper. The former largely determines the degree of success, or at all events the method of carrying out, of electrical power transmission schemes; while the latter, in conjunction with the permeability of iron, actually decides the scale upon which our electrical machinery must be built, since the output or effort for a given speed of running is always limited by the heating which occurs; and this, at full load, arises mainly from the imperfect electrical conductivity of copper.

Aluminium offers, it is true, no prospect of reduced size of our machinery, owing to its bulk (*diameter* nearly 30 per cent. greater than equivalent copper); but it will now always act as a check upon the artificial raising of the price of copper.

The high cost of insulating materials renders it unlikely that aluminium with its greater size will ever replace copper in insulated cables. And even as a bare conductor, it is doubtful what advantage in price (together with whatever saving may come from having wires only half as heavy to handle and support) will compensate for the many disadvantages as compared with hard-drawn copper—greater liability to corrosion, difficulty of making joints, less tensile strength (even of aluminium bronze), lack of uniform quality, greater surface exposed to the wind, greater unsightliness owing to size (for trolley wires), &c.

Still, the excessive price of copper which has obtained during the last two years, and indeed till a few months ago, has led to the putting down of between one and two thousand tons of bare aluminium conductors for electric-power transmission—chiefly in America, and for very high-tension, long-distance schemes—schemes, in fact, in which the cost of the lines represents the greatest proportion of the whole expenditure.

The experience as to the behaviour of aluminium already gained from these installations is very valuable, as may be gathered from a perusal of two recent papers—one read by Messrs. Perrine and Baum before the American Institution of Electrical Engineers, and the other by Mr. Kershaw before our own similar Institution. The former writers find that, owing to a large temperature change in the elastic constant, the true coefficient of expansion of the new metal is not applicable in calculations of stresses in suspended wires having a given sag, the apparent temperature effects being much less than those calculated. Again, in the latter paper it is suggested that aluminium will not weather so well in this country as in the drier climate of America. It would seem also as if, while good soldered joints are quite possible with the metal, only welded or "burnt" joints involving no solder are durable out-of-doors, the metal being so highly electropositive, and the alloys formed near soldered joints unstable. Mechanical joints are generally used in America. The McIntyre joint is made by slipping the ends into a flat aluminium sleeve, the whole being then twisted round twice or thrice. It is doubtful whether such joints retain their initial high conductivity, in view of experience with similar joints in telegraph work. As an electrical conductor, then, it is only in those rare cases where conducting power for a given weight is wanted, *irrespective of volume*, that aluminium is without question the best material to use.

For structural purposes, the new metal has up to the present proved a little disappointing. In the first place, the pure metal is useless, being too soft. This, however, was to be expected. Pure iron is also soft. The alloys with copper up to a density of 3 include some which seem fairly strong; but the fact that cycle frames are still made of steel shows that, where strength and lightness are required together, and cost is not of great moment, steel can still hold its own, apart from its relative cheapness. No doubt, however, there is yet much to be learnt about the metallurgy of the alloys with copper, and with other elements also—nickel, tin, magnesium, &c.

A considerable demand for aluminium has grown up in connection with the manufacture of a great variety of small articles, instruments, &c. The most important uses of the metal from a commercial point of view are based upon the activity of its reactions at a high temperature. Added in small quantities to molten iron just before a cast is made, the metal is rendered more fluid and the quality of the casting thereby improved.[1] This result appears to be due to the reduction by the aluminium of any iron oxide which may be present, and to the raising of temperature of the iron itself by the heat of the action. It was stated by Swan, in a recent presidential address in Glasgow, that this use of the metal formed one of the chief outlets for the 6000 odd tons of aluminium which were manufactured last year.

The Goldschmidt process, by which the most intense heat can be produced in any required amount at a given point also depends upon the same fact, that aluminium can reduce iron oxide with energy to spare. A mixture of finely-divided aluminium and iron oxide, known as "thermit," can be ignited by a suitable fuse, and results in a quantity of molten iron heated far above the melting-point and protected from combustion by a layer of alumina. This iron, being so very greatly superheated, will serve for a variety of purposes, and its quality can be varied as required by suitable additions to the "thermit." This process was lately described and demonstrated at the Royal Institution by Roberts-Austen,[1] to whom, indeed, it is largely due. It has been applied to the welding of rail joints in position for electric traction, and to the repairing of broken and of faulty steel castings. The process has, in fact, many of the possibilities of the electric furnace, without the drawback of being dependent upon a fixed and costly electrical installation.

[1] See "The Relations of Aluminium to Iron," by Godfrey Melland (*Proc.* Staff. Iron and Steel Inst., 1900).

[1] "Metals as Fuel," Royal Institution Lecture (NATURE, August 8, 1901).

THE OCTOBER ORIONIDS.

IN many previous years the Orionid radiant has been well defined at a point very close to, if not coinciding with, the position of the star ν Orionis (mag. $4\frac{1}{2}$). The shower was very successfully observed by Prof. A. S. Herschel on about October 18–20 in the years 1864, 1865 and 1867, when the centre of divergence was found to be at $90^\circ + 15^\circ$. A number of observations were obtained at Bristol in 1877, 1879, 1887 and other years, and the radiant derived from them was at $91^\circ + 15^\circ$. The meteors of this shower belong to the swifter class, and they leave streaks which enable their directions of flight to be so correctly noted that the centre of emanation not only appears sharply defined, but can be very accurately located. The streaks frequently linger for two or three seconds and will sometimes very perceptibly brighten up after the heads of the meteors have vanished.

The observations in 1900 and 1901 made at Bristol show that the true Orionids were feebly represented and that, in fact, the annual shower-meteors from the old position at ν Orionis had been supplanted by a more active radiant of Geminids agreeing in place with the star ξ Geminorum (mag. $3\frac{1}{2}$). On October 23–27, 1900, and October 20, 1901, I recorded about twice as many meteors from $100^\circ + 13^\circ$ as from $91^\circ + 15^\circ$. The observations were not very numerous, but had they been far more complete there is no reason to suppose that the conclusions would have been materially affected.

The difference of 9° in the positions of the radiants at ν and ξ Orionis is sufficiently large to be immediately detected by meteoric observers though their materials are merely eye estimations. The latter are, however, unusually trustworthy, not only in the case of the Orionid display, but also in regard to some of its bordering and contemporary showers which furnish similar objects. The flash of a meteor's head as it darts rapidly along in a state of combustion attracts the eye to the point of appearance, and the streak which immediately glows along the path enables the observer to fix the apparent direction of flight with almost instrumental precision.

In the *Monthly Notices* for December 1895 (vol. lvi. p. 74) I mentioned the γ Geminids as one of the most prominent companion radiants of the Orionids and gave the mean position of the centre as 97°·1 + 15°·2 from thirteen observations by various observers. In the "General Catalogue of Radiant Points" (*Memoirs* R.A.S., vol. liii.) this shower forms No. lxxix. and the radiant is given at 96°·6 + 16°·5, based on nineteen observations. But there is now reason to believe that these positions are two or three degrees north of the correct place and that instead of corresponding with the star γ Geminorum it really agrees with ξ Geminorum. Certainly in 1900 and 1901 the most conspicuous shower of rapid streak-leaving meteors was directed from 100° + 13°, the position of the star ξ Geminorum for January 1901 being α = 6h. 39m. 44·0s., δ = 13° 0′ 9″·1 +.

It will be interesting to watch future returns of the October meteors in order to ascertain whether the formerly strong shower at ν Orionis has only been temporarily weak during the few past years or whether it has finally withdrawn in favour of its easterly companion radiant at ξ Geminorum. Possibly the swarm of Orionids has been recently disturbed by planetary attraction and the node displaced sufficiently to bring about a change of 9° in the radiant. If so, the principal meteoric display of October must henceforth be known as Geminids instead of Orionids. But the more probable supposition appears to be that the Orionids have been very scantily distributed along those parts of their orbit traversed by the earth in late years, whereas the neighbouring shower in Gemini has been so much stronger than usual as to form the principal display of the epoch. The Orionid system used to present itself with considerable regularity like the August Perseids, though it exhibited variations of strength in part no doubt attributable to the different atmospheric conditions prevailing, to the position and age of the moon and to other circumstances capable of affecting the visible aspect of the stream.

W. F. DENNING.

ARMOUR-CLAD WHALES.

AMONG the many wonderful palæontological discoveries that have startled the scientific world during the last few years, none, perhaps, is more unexpected than the revelation that the ancestral whales were protected from attack by a bony armour analogous to that with which the armadillos of South America are covered. Scarcely less marvellous is the fact that vestiges of this ancient coat of mail are still borne by such familiar cetaceans as the porpoise and its near relative the Japanese porpoise (*Neophocaena phocaenoides*), the latter species being distinguished by the absence of a back-fin. That creatures like the modern pelagic whales and porpoises, or even the river dolphins, could ever have been invested with a complete bony armour is, of course, an absolute impossibility. The rigidity of such a panoply would have interfered far too much with the mobility of their supple bodies, while its weight would have impaired their buoyancy. Consequently it is necessary to assume that in even the earlier representatives of these types the armour must have been in a condition of degradation and elimination, so that we must go back to still earlier forms to find it in its full development. As every one knows nowadays, whales and dolphins trace their ancestry to land animals, and it appears highly likely that when such ancestral creatures began to take to an amphibious life on the sea-shore, or at the mouth of a large river, they may have developed a dermal armour which would serve to protect them alike from the breakers and from the attacks of sharks and other marine monsters. For the idea that the terrestrial ancestors of the cetaceans were clad in armour cannot for a moment be entertained, since the primitive mammals were not so protected and the American armadillos afford an instance of the development *de novo* of such a bony panoply at a comparatively recent epoch.

Years ago the late Dr. H. Burmeister described a porpoise from Argentina as *Phocaena spinipinnis*, on account of its possessing a number of spiny tubercles embedded in the skin in the neighbourhood of the back-fin as well as on the fin itself. "Some small spines," he writes, "begin in the middle of the back, at the distance of 25 centimetres in front of the fin, as a single line of moderate spines; but soon another line begins on each side, so that in the beginning of the fin there are already three lines of spines. These three lines are continued over the whole rounded anterior margin of the fin and are augmented on both sides by other small spines irregularly scattered, so that the whole number of lines of spines in the middle of the fin is five." In a section of the skin of the back-fin the tubercles are distinctly seen, many of them being double.

Similar tubercles were described on the back-fin of a porpoise taken in the Thames in 1865; and quite recently a row of no less than twenty-five well-developed tubercles has been detected on the front edge of the back-fin of a fœtal porpoise, these tubercles being nearly white and thus showing up in marked contrast to the dark-coloured skin. Even more distinct are the tubercles in the skin of the finless back of the Japanese porpoise, where they form several rows of polygonal plates.

In a fossil porpoise (*Delphinopsis freyeri*) from the middle Tertiary deposits of Radoboj in Croatia, the tubercles were still more strongly developed, and formed a series of regularly arranged and parallel rows in the neighbourhood of the back-fin. They clearly indicate one step from the modern porpoises in the direction of a species provided with a functional bony armour in this region of the body. Between the extinct Croatian porpoise and the much more ancient whale known as *Zeuglodon*, some part of whose body was protected by a bony armour as solid as that of the giant extinct relatives of the modern armadillos, the intermediate links are at present unknown, although they may turn up any day. *Zeuglodon* was first discovered in the early Tertiary strata of the United States, but its remains have subsequently been obtained from the equivalent deposits of Egypt and elsewhere, and in early times it was probably the dominant cetacean of the world. Years ago there were discovered with the bones of the internal skeleton of this whale a number of bony plates which originally formed a dermal armour; although they were regarded as belonging to a species of leathery turtle and as having nothing to do with the whale.

But in microscopic structure, as well as in their arrangement, these polygonal bony plates differ altogether from the armour of the leathery turtle; while their structure is generally similar to the undoubted bones of *Zeuglodon* with which they are found in association. Moreover, a fragment covered on one side with armour of this type has been discovered which cannot, apparently, be any part of the shell of a turtle, but which may well be the back-fin of *Zeuglodon*. And as the aforesaid bony tubercles of the porpoises are always found on or near the back-fin, it is a safe assumption that in *Zeuglodon* the entire dorsal fin, as well as some portion of the back, was covered with a complete tessellated armour of bony plates.

The majority of the living toothed whales (inclusive of porpoises and dolphins) are furnished with a dorsal fin, and it is therefore reasonable to suppose (apart from the evidence of the specimen just referred to) that *Zeuglodon* was similarly provided; and if this be so, that cetacean was evidently a pelagic creature. For the function of a dorsal fin is to act as a kind of keel in maintaining the balance of the body, this appendage being most developed in purely pelagic cetaceans like the killer, while in littoral or fluviatile forms, such as the narwhal, the white whale and the Japanese porpoise, it is either small or wanting. It is, further, noticeable that cetaceans with pointed muzzles (of which *Zeuglodon* is one) nearly always have a larger back-fin than those in which the muzzle is short and rounded. In the whalebone bones, among which the dorsal fin is either small or wanting, its function may be discharged by the keel on the middle of the upper jaw, or, owing to corporeal bulk, no such function is required at all.

If, then, we are right in regarding *Zeuglodon* as a pelagic cetacean, it is evident that it could not have been completely armoured, but that such armour as it retained was merely a survival from a fully armoured non-pelagic ancestor. For it is almost impossible to believe that the ancestral cetacean was not invested in a complete panoply, at least on the dorsal region.

The whole argument is tersely summed up as follows by Dr. O. Abel (*Beitr. Pal. Öster.-Ung.*, vol. xiii. pt. 4, 1901), to whom naturalists are indebted for these interesting researches.

In their earliest stage of development the toothed whales were fully armoured. The object of the armour was as a defence against enemies, such as sharks, such an armour being also very valuable to animals exposed to the force of a strong surf on rocky shores. As the creatures took more and more to an aquatic life, the acquisition of greater speed would be of greater value to them, and this would be accomplished by diminishing the specific gravity and friction of the body, the shortening of the extremities and the development of a caudal fin to serve as the sole instrument of locomotion.

Accordingly the armour would very soon be lost by the pelagic cetaceans in order to diminish friction and lighten the specific gravity. Only among certain types, which diverged at an early epoch from the ancestral stock and took to a fluviatile or estuarine life, did vestiges of the armour persist, while the dorsal fin remained undeveloped (*Neophocaena*). That in this form, as well as in the closely allied true porpoises (*Phocaena*), we have the most primitive type of living toothed whales, is confirmed by the nature of their dentition, as well as by the circumstance that in this group alone the premaxilla is toothed. The relation of the interparietal to the parietals is likewise confirmatory of the antiquity of the porpoises.

As many of our readers are aware, *Zeuglodon* differs from modern cetaceans by the characters of its teeth, those of the lateral series being double-rooted and having compressed and serrated crowns, distantly recalling those of the leopard-seal. Between *Zeuglodon* and the shark-toothed dolphins (*Squalodon*) the gap is very great, but still one which might readily be bridged were the missing links forthcoming; and as it is the molars of the one type seem derivable from those of the other. In *Squalodon* the molars alone retain the double-rooted character of *Zeuglodon*, and a transition from the former, in respect of tooth characters, to the modern dolphins and porpoises is afforded by *Saurodelphis*, of the Argentine Pliocene, in which the roots of the teeth, although single, are elongated antero-posteriorly and thus display clear evidence of their original duality. By Dr. Abel, *Saurodelphis* is indeed regarded as occupying the middle position between *Squalodon* and the modern dolphins; but the porpoises are considered to form a side branch which diverged from the main stem at an earlier date than the appearance of the genus first named.

In conclusion, it may be mentioned that modern investigations tend to connect the ancestral toothed whales with the Carnivora, and in no wise support Sir William Flower's favourite idea that these cetaceans trace their descent from early Ungulates. R. L.

TIBET AND CHINESE TURKESTAN.[1]

THE geographical area illustrated by Captain Deasy's book lies in one of the most remote and, at the same time, one of the most interesting regions (regarded politically) in the whole continent of Asia.

British India (represented by Kashmir) lies south and west of it; to the north, north-east and east stretch the shadowy outlines of the "new dominion" of China and the lofty uplands of Tibet; Russia looms large to the north-west; and a long thin slice of Afghanistan reaching out an arm eastwards nearly touches it on the western border. It is an area which bristles with the physical difficulties presented by a vast array of gigantic mountain chains interspersed with flat spaces of desolate upland and salt marsh, and it is an area which those high authorities who regulate international boundaries will sooner or later find it necessary to discuss in close detail; for hereabouts exists one of the nebulous corners of the Empire. Boundary commissions have come and gone, but they have still left undecided the question how far China extends south, or Kashmir north; nor can anyone give final shape to Russia's line of boundary where she leaves Afghanistan and spreads eastward towards China. Consequently Captain Deasy's geographical work, and the interesting book in which it is described, possess a value which can only be regarded as unique. It is only by the light of his excellent map that any conclusions can be drawn as to the physical nature of this rugged no man's land, and only by the light of his description of it can any value be assigned to its apparently desolate hills and valleys. It is no small achievement for a cavalry officer to carry the principles of scouting on scientific geographical lines into such a field of difficulty and desolation as is presented by the buttressed spurs of the Kuen Lun and the Muztagh ranges.

Captain Deasy has set a most excellent example to aspiring travellers in remote regions—an example which has been lately emphasised strongly by the methods of the great traveller Sven Hedin—in the careful preparations which he made for the scientific prosecution of his work. He is not merely an observer. He has proved himself to be an advanced geographical surveyor. He first armed himself with all available data on which to base his exploration, and then attached himself to the best of all possible schools of instruction in order to learn how to make the best use of it. The result is a map which is probably quite accurate enough to take its place as the standard geographical reference for all that part of High Asia with which it deals, and which must be regarded as the most important result of his combined literary and field efforts. His observations were all worked out by the professional computers of the Indian Survey, and the results are tabulated and a record made of their value, in the appendix to his book; so that the indefinite haze which usually envelops similar records by less careful workmen is absent in Captain Deasy's work, and we know precisely what to make of it. The book, which embraces the narrative of his travels (illustrated by an excellent series of photographs), is written with the traditional modesty of a soldier, and gives a faithful and graphic account of the extraordinary difficulties which beset the travellers in the Tibetan borderland. There is no occasion to exaggerate these difficulties, or to draw on the imagination for thrilling episodes and situations. They are formidable enough to tax all the resources of ability and determination which the best of explorers may have at his command. If Captain Deasy's own description of them hardly does justice to the extraordinary obstructiveness of the ugly passes of the gigantic Tibetan ranges, his illustrations at least do not fail to make it plain. It is almost

[1] "Tibet and Chinese Turkestan." By Captain Deasy. Pp. xvi + 420. (London: T. Fisher Unwin, 1901.) Price 21s.

inconceivable to anyone who has not witnessed the experiment, that such passes should be negotiable at all, even if the gymnastic capacity possessed by the yak or by the coarse-bred and clumsy Yarkandi pony be duly appreciated.

Captain Deasy's narrative is a plain and simple record of a very remarkable series of explorations. It cannot fail to be interesting to all who love adventure, or who discern a future of political difficulty looming on the borders of Tibet. It is interesting to the geographer for many reasons, not only because it illustrates certain methods which should be adopted by every modern scientific traveller in Asia, but because it solves many an old geographical problem and suggests one or two new ones. Amongst other important determinations, that of the altitude of the Muztagh-Ata of Sven Hedin (which is now definitely ascertained to be 24,000 feet above sea-level) fixes the height of the highest peak north of the Himalaya. T. H. H.

FIG. 1.—Scene in the Takla Makan.

NOTES.

THE president of the Board of Education has appointed Prof. Hugh L. Callendar, F.R.S., to the professorship of physics in the Royal College of Science, South Kensington, in succession to Prof. Rücker, who, as already announced, has become principal of the University of London.

THE Duke of Devonshire has suggested a reason for the tentative way in which the problem of our educational organisation has been attacked. In opening the new Central Technical School at Liverpool on Saturday he placed the responsibility for the present state of affairs upon educational authorities, religious and political bodies, employers, workmen, parents and other representatives of the community, because "the only source of strength by which the Government could hope to surmount the difficulties would be the conviction of public opinion of the importance of education itself and the necessity for its extension and organisation." He anticipated the criticism that must be passed upon such a statement by saying "He would probably be told he was whistling for a wind; that he was asking for an expression of public opinion which would guide the Government in forming either large or small proposals on the subject of education. He did not altogether resent the imputation." It is clear from this that our Ministers acknowledge that they are not leaders so far as education is concerned. The Lord President's reference to whistling for a wind is unhappy when other nations are going full speed ahead under steam. Dr. Macnamara puts the case very forcibly in a letter to Tuesday's *Times*, where he remarks that what the British people ought to give the Government is, not a breeze, but a tornado. Something should be done to bring about this storm and so waken our rulers into activity. The education question is too important to be permitted to drift along as it has done; and even now it will be a hard task to make up the leeway. Our educational deficiencies are obvious to everyone who has given consideration to the subject. Report after report has been published showing that we only occupy a fifth-rate position when considered from the point of view of provision made to equip people for the industrial struggles of the future. The Government knows this, but it can scarcely appreciate the fact that national progress depends upon intellectual equipment, or it would hasten to do something to organise and extend our educational system.

THE following is the text of the address of congratulation presented to Prof. Virchow, on the occasion of his eightieth birthday, by those members of the Anthropological Section of the British Association who were present at the recent Glasgow meeting:—"British Association for the Advancement of Science: the Section of Anthropology to Prof. Rudolph Virchow:—It seldom falls to the lot of one man to establish a position, as you have done, as a leader in two great branches of science. Throughout the world you are generally recognised as the founder of modern pathology, whilst in the domain of anthropology your services have been hardly less remarkable. Whenever anthropologists meet together, your name is mentioned with the respect a d reverence that are due to a great master. At the present moment the British Association for the Advancement of Science is holding its annual meeting in Glasgow, and the members of the Anthropological Section, aware that you celebrate your eightieth birthday on October 14, desire to convey to you their affectionate greetings, and to express the hope that you may be spared to add yet further to the indebtedness which they owe to you as a worker in the same field. Signed on behalf of the committee of the Anthropological Section, D. J. Cunningham, president, J. L. Myers, recorder. Glasgow, September 11, 1901." The address, richly engrossed, was presented personally to Prof. Virchow by Lord Lister in the course of the celebration ceremony at Berlin.

To remove any misapprehension as to his opinion upon the result of M. Santos Dumont's recent aërial performance, M. Deutsch has written him a letter stating that he considers the trip to have been completely successful and that the prize has been won. M. Deutsch sent M. Santos Dumont at the same time the sum of 1000*l.*, which the latter has handed to the Prefect of Police for distribution among the poor of Paris. The committee's decision concerning the prize of 4000*l.* has not yet been announced.

SIR H. TRUEMAN WOOD will deliver the next Christmas Juvenile Lectures at the Society of Arts, the subject being "Photography and its Applications." The idea will be to show in what a large number of cases photography has been applied to scientific observation, and how varied are the applications. The subject is an interesting one and ought to prove very attractive. The dates of the lectures are January 1 and 8.

SIR HIRAM S. MAXIM confirms the observation mentioned in our issue of October 17 (p. 607) of the attraction which certain sounds have for mosquitoes. Writing to the *Times*, he states that one of the electric lamps which he put up at Saratoga Springs, New York, in 1878, emitted a musical note; or rather the note proceeded from the box containing the dynamo machine under the lamp. One evening whilst examining the lamp he found that everything in the immediate vicinity was covered with small insects. They did not appear to be attempting to get into the globe, but into the box that was giving out the musical note. A close examination of these insects showed that they were all male mosquitoes. Although there were certainly 200 times as many female mosquitoes on the ground as males, not a single female mosquito was found to have been attracted in the least by the sound. Sir Hiram Maxim remarks that "when the lamps were started in the beginning of the evening every male mosquito would at once turn in the direction of the lamp, and, as it were, face the music, and then fly off in the direction from which the sound proceeded. It then occurred to me that the two little feathers on the head of the male mosquito acted as ears, that they vibrated in unison with the music of the lamp, and as the pitch of the note was almost identical with the buzzing of the female mosquito the male took the music to be the buzzing of the female."

PROF. E. RAY LANKESTER has been elected a corresponding member of the Royal Society of Sciences of Göttingen.

THE exhibits of the German Chemical Industry Section at the Paris Exposition, valued at 30,000*l.*, have, it is said, been presented to the Technological Institute of the Berlin University.

MR. G. W. DE TUNZELMANN has been appointed editor of *Science Abstracts* in succession to Mr. W. R. Cooper, and will take over the duties of the office on January 1 next.

A SICILIAN agricultural exhibition is, according to a Consular Report, to be held at Palermo from March to May next. There will be a class for international agricultural machinery.

THE new specimens added to the Museum of Anatomy and Pathology at University College, Gower Street, will be on view until November 2.

THE Bradshaw lecture will be given before the Royal College of Physicians on November 5 at 5 p.m., by Dr. J. S. Bury. The subject will be "Prognosis in Relation to Disease of the Nervous System."

On Tuesday next, November 5, the president of the Institution of Civil Engineers will deliver his inaugural address, distribute the council's awards, and hold a reception. The meeting will take place at 8 p.m.

THE Lettsomian lectures of the Medical Society of London will be delivered on February 17 and March 3 and 17 next, at 9 p.m., by Mr. A. Pearce Gould, who will take as his subject "Certain Diseases of the Blood Vessels." The annual oration will be delivered on May 26 by Dr. Stephen Mackenzie.

ACCORDING to the *British Medical Journal*, Surgeon-Gen. Wyman, of the U.S. Marine Hospital Service, proposes to establish an institute for the study of yellow fever. The work will be divided into four departments or sections, viz., history and statistics, etiology, transmission, quarantine and treatment. An executive board is to have general charge of the investigations and the publication of reports.

A DETAILED account of the relationship between mosquitoes and the spread of yellow fever is given in the Paris *Bulletin Medical* by Dr. H. de Gouvèa, who studied the subject for many years in Brazil. Dr. Gouvèa shows that the conditions of propagation of the disease have always been such as to fulfil the requirements of the mosquito hypothesis, and to afford abundant indirect evidence in favour of the belief which has now been reached by more direct methods. In conclusion, he formulates a series of propositions—namely, that yellow fever is never conveyed by either direct or indirect contagion; that the actual cause of it, at present unknown, will in all probability be discovered in the human blood; that it is diffused only by the agency of the mosquito, *Culex toeniatus* or *fasciatus*; and that immunity from it may be secured by the destruction of these insects, or by avoidance of their haunts during the periods of their activity.

A DIFFICULTY has arisen concerning the site on which the new Pasteur statue in Paris shall be erected. The use of a space in the Square Médicis in the Quartier Latin has been granted, but this spot is being tunnelled for a railway, and it is feared, in consequence, that the statue may be too weighty for it. Other places, such as the Place du Panthéon, the Place de la Sorbonne, and the entrance of the Avenue de l'Observatoire, are under consideration.

A COMMITTEE of the Association of Chambers of Commerce meeting recently unanimously adopted the following resolutions:—"(1) That, after considering various suggestions, this committee is unanimously of opinion that the Chambers should unite in urging upon the Government the compulsory adoption of the metrical system of weights and measures, leaving matters of detail to be considered later. (2) That the committee is unanimously of opinion that a British decimal system of coinage must be on the basis of retaining the sovereign, with the florin as a unit, divided into a hundred cents or farthings. (3) The committee recommends that there should be nickel coins of five and ten cents, and bronze coins of one, two and four cents or farthings."

MEETINGS of the committee appointed by the Board of Trade to inquire and report as to the best means by which the State or local authorities can assist scientific research as applied to problems affecting the fisheries of Great Britain and Ireland took place on Tuesday, Wednesday and Thursday of last week for the purpose of taking evidence. Sir Herbert Maxwell, M.P., presided. Dr. T. Wemyss Fulton, scientific superintendent to the Scottish Fishery Board, and Mr. E. W. L. Holt, scientific adviser to the fisheries branch of the Department of Agriculture, &c., Ireland, were examined, and Mr. G. C. Bompas and Prof. G. B. Howes gave evidence with regard to the Buckland fish collection at South Kensington. Prof. E. Ray Lankester, the president, and Mr. E. J. Allen, the director, of the Marine Biological Association, and Mr. R. A. Dawson, superintendent under the Lancashire and Western Sea Fisheries Committee, also attended. Prof. Herdman, who is a member of the committee, submitted a scheme for fishery investigations in the Irish Sea, and the committee adjourned till December 3.

MR. J. STIRLING, Government Geologist, &c., Victoria, is to lecture at the Imperial Institute on November 18, on "Brown Coal Beds of Victoria, their Characters, Extent and Commercial value"; on December 9 Mr. D. Hutcheon, chief veterinary surgeon for Cape Colony, is to speak on "Agricultural Prospects of Cape Colony," and on December 16 Mr. H. N. Ridley, director of the Botanic Gardens, Singapore, will deliver an address on "The Economic Resources of the Straits Settlements and the Malay Peninsula." All the meetings will take place at 8.30 p.m.

THE provisional programme of the new session of the Royal Geographical Society has just been issued and contains the following arrangements:—November 11, the opening address by the president, and "The Uganda Protectorate, Ruwenzori and the Semliki Forest," by Sir Harry Johnston, K.C.B.; November 25, "Four Years' Travel and Survey in Persia," by Major Molesworth Sykes; December 9, "The Glaciers of Kanchinjunga," by Mr. Douglas W. Freshfield. Among the other papers which it is expected will be delivered during the session may be mentioned:—"A Journey from Omdurman to Mombasa by Lake Rudolf," by Major H. H. Austin, R.E.; "The Maldives," by Mr. J. Stanley Gardiner; "Journeys in Western China," by Dr. R. L. Jack; "The Influence of Geographical Conditions on History and Religion, with special reference to Asia Minor," by Prof. W. M. Ramsay; "An Expedition across Abyssinia, through Kaffa and the Region to the West and North," by Mr. Oscar Neumann; "Southwards on the Antarctic Ship *Discovery*," by Mr. George Murray, F.R.S., and Dr. H. R. Mill; "The Bedford Level and Experimental Demonstration of the Rotundity of the Earth," by Mr. H. Yule Oldham; "The Snows of Canada," by Dr. Vaughan Cornish; "A Journey from Quetta to Meshed by the new Nushki Trade Route," by the Earl of Ronaldshay; "The Ice Conditions of the Antarctic," by M. Henryk Arçtowski; "Methods and Appliances in the Teaching of Geography. Special Lecture for Teachers," by Mr. A. W. Andrews.

AN exhibition of scientific apparatus constructed by pupils and teachers of the London School Board for the purpose of teaching and illustrating some of the branches of experimental science is opened to-day at the Examination Hall, Victoria Embankment, and will remain open until Monday next. No charge is made for entrance, and the Board invite the inspection of the exhibits. Among the latter are to be found induction coils, telegraph instruments, motors, voltameters, galvanometers, Boyle's tubes, balances, and lantern and microscopic slides. There will also be shown dissections in a preservative spirit, such as a skate's ear, sheep's kidney, rabbit's lung, &c.

PROF. BASHFORD DEAN, says *Science*, has returned to Columbia University, bringing with him from the east an almost complete series of developmental stages of the Port Jackson shark, *Heterodontus japonicus*, a number of stages in the development of Chlamydoselachus, two new Myxinoids, a new Chimæra, together with a general zoological collection. During a visit to the Hokkaido (Yezo), he brought together several hundred specimens of Aino antiquities, which are now deposited in the American Museum of Natural History in New York. He also secured a collection of interesting glass sponges from the region of Misaki, which are also destined for the American Museum. Among other specimens are included a number illustrating artificial selection, a series of the highly specialised varieties of Japanese gold fishes, together with a number of the long-tailed fowls of Tosa, whose tail feathers sometimes reach the extraordinary length of fifteen feet. For the Columbia collection he obtained during a visit in southern Negros, P.I., a series of dissections of Nautilus, prepared from fresh material.

THE steam yacht *Antarctic* called at Falmouth on Saturday last and left on the same day with the members of the Swedish Antarctic Expedition on board. The leader of the expedition is Dr. Otto Nordenskjöld, whose work in Tierra del Fuego and Spitsbergen is well known to geographers. Other members are Captain Larsen; Dr. A. Ohlin and Mr. K. Anderson, zoologists; Mr. C. Skottsberg, botanist; Dr. G. Bodman, magnetician and hydrographer; and Dr. E. Ekelöf, medical officer and bacteriologist. From an article in the *Times* we learn that the vessel will proceed direct to Buenos Ayres, and thence by Staten Island (where the instruments will be compared with those of the Argentine scientific station) and the Falkland Islands, to the South Shetlands and the east coast of Graham Land (King Oscar Land), where, if a suitable spot for the winter quarters can be found, a station will be established for six or seven persons, under the command of Dr. Nordenskjöld himself, and observations carried out in harmony with those of the British and German expeditions. If, however, suitable quarters cannot be obtained, the winter station will be established somewhat further north. In any case, the ship, with two or three of the scientific observers, will return to South America and the Falkland Islands for the winter, after the best possible use has been made of the Antarctic summer.

A SHORT account of Antarctic exploration, and of the problems which still await solution by systematic observations in South Polar regions, is contributed to the October *Quarterly Review*. The German and British ships, the *Gauss* and the *Discovery*, have each been described as the best which have ever left on voyages of discovery, but the *Quarterly* reviewer demurs to this estimate, and remarks that Admiral Makaroff regards both the vessels as at least half a century behind the times. A steel ship like the great icebreaker *Ermack* is suggested as more serviceable than wooden vessels. "All who have inspected the *Ermack*, or have made a voyage in her, will probably admit that she is the most powerful and efficient vessel afloat for exploration, and the best equipped and most convenient for scientific observation and research. Should the Tzar send this splendid ship to the Antarctic seas next season her operations would most certainly result in large additions to knowledge in directions which cannot be attempted by the *Discovery* and the *Gauss*."

FROM the point of view of modern shipbuilding, the opinion expressed in the foregoing note upon the *Discovery* as a ship for scientific exploration is probably correct, but for obvious reasons it was impossible to design and build a vessel regardless of expense. From despatches just received by Sir Clements Markham from the Cape, it appears that the *Discovery* must be accounted a poor sailer, though she has proved to be a good sea boat. Her coal consumption is, however, disappointing, the economy of the engines being less than was expected. The ship leaked from causes which can no doubt be obviated, but the defect has necessitated clearing the holds to construct floors with an ample bilge space beneath, so that the provision cases be preserved from injury. These facts accentuate the importance of providing a relief ship to communicate with the *Discovery* at the end of the first winter, to take out coals and stores, and to render assistance in other ways. A strong appeal is to be made to supplement the funds already subscribed for this purpose. The sum of 6680*l*. has been obtained, but a further amount of 10,000*l*. is required, and this should be secured without delay.

A STRIKING testimony as to the value of Dr. Calmette's antivenene is to be found in an extract from a report by the medical officer on an Indian railway line which the current issue of the *Lancet* contains. "On the night of the 23rd [of August] I was called," says the medical man in question, "to see a coolie woman who had been bitten by a large snake supposed to be a cobra. She was said to have been bitten at about 7 p.m. and I did not see her till two hours later. She was then practically moribund, the throat paralysed, and consciousness completely lost. All the symptoms of poisoning by colubrine venom were well marked. I injected a full dose of Dr. Calmette's antivenene, but was not sanguine as to the result, the patient's condition being apparently hopeless. The effect of the remedy was marvellous; consciousness returned in fifteen minutes, and I was so encouraged by the result of the first injection that I decided to give another dose of the serum. It acted like magic and within three hours of the first injection the patient was well."

WE have received from Signor Palazzo, director of the Italian Meteorological Service, an account of the organisation of special stations for the study of hail and thunder storms and for carrying on further experiments as to the possibility of dispersing thunder clouds by gun firing. Although scientific men are very sceptical about the efficacy of the practice, the majority of Italian agriculturists are very enthusiastic in the matter, and the Government has consequently voted 10,000 lire for the establishment of two shooting stations in the most suitable localities and has provided them with the most sensitive instruments for predicting the advance of the storms, and with means for tracing their course and the amount of damage caused. Up to the present time the results obtained are contradictory; in some cases the firing appears to have had a favourable effect, while in others the firing apparatus itself has been choked by the falling hail. The inquiry will, at all events, be useful in throwing light upon the propagation and characteristics of thunderstorms.

THE twenty-third annual report of the Deutsche Seewarte, for the year 1900, shows that the subject of maritime meteorology has been prosecuted with increased activity; 75 complete logbooks were received from the Navy and 472 from the mercantile marine, in addition to which 299 abstract logs containing less complete observations were received. The consulates in various parts of the world, including several in this country, act as agencies for meteorological purposes. The observations are published in the form of tabular results referring to ten-degree squares, or districts of the ocean, and are utilised in the construction of the daily synoptic weather charts of the North Atlantic. The department dealing with weather telegraphy is also very active, and has made great endeavours to improve the service by the introduction of direct interchange of reports made at 7h. instead of 8h. a.m., a practice which is being followed by most countries, whereby weather information is disseminated earlier than before, with a consequent increase of utility. In this matter Dr. Neumayer has been very ably supported by Dr. van Bebber, the superintendent of the section engaged in weather prediction.

MANY attempts have been made to generalise the methods of "casting out" the nines or elevens so as to obtain in a simple form the criterion of divisibility of high numbers by factors other than 9 or 11. For example, we have the well-known test for divisibility by 7 or 13 which consists in pointing the given number off in thousands and subtracting the sum of the numbers in one set of alternate groups from the sum of those in the other set. Such generalisations date as far back as a paper in the works of Blaise Pascal published in 1779. Prof. Gino Loria, writing in the *Atti dei Lincei*, x. 7, now gives an investigation of the criteria of divisibility by any integer in a comparatively simple form.

A SERIES of experiments on the period of a rod vibrating in a liquid is described by Mary J. Northway and A. Stanley Mackenzie in the *Physical Review* for September. The lowering of pitch, which is, of course, due mainly to the inertia of the fluid particles, is found in these experiments to conform to the following general approximate results:—The interval of lowering for a rod of given cross section is independent of the length. It is also approximately the same for brass and steel and is probably independent of the material within the range of substances ordinarily used. The interval of lowering for a rod of given width is approximately inversely proportional to the thickness, while for a rod of given thickness it is approximately directly proportional to the width. From the experiments, which were made both in water and cotton-seed oil, the authors calculate for the rods of different section the coefficient by which the mass of the displaced liquid must be multiplied in order, when added to the mass of the solid, to represent the effect of fluid inertia, *i.e.* the well-known coefficient which is proved in hydrodynamics to be unity for a cylinder and one half for a sphere moving in perfect fluid. The rods used in these experiments appear to have had a rectangular cross section. It would be interesting to inquire whether they had sharp edges, and under what conditions such edges tend to increase the damping of the oscillations.

THOSE engaged in or about to commence the production of coloured pictures by means of a camera will find much to interest them in the catalogue of apparatus, material and appliances which has just been received from Messrs. Sanger Shepherd and Co. In the process under consideration, many of the difficulties that were conspicuous in the Ives process have been eliminated, so that the procedure is in the reach of every photographer and the equipment required reduced to a minimum. By using the very carefully adjusted colour filters and printing-colours of exactly the correct absorption, which are here placed within the reach of anyone, and by providing oneself with the repeating back for the three separate negatives, a perfectly efficient outfit is secured. To make the coloured pictures, full instructions are added in a special pamphlet. The ordinary lantern may be used for throwing the pictures on the screen, and brilliant discs up to 12 feet diameter can be shown with the ordinary oxyhydrogen limelight; and with the electric arc discs up to 20 or 30 feet. A further pamphlet of Messrs. Cadett and Neall, Ltd., contains a concise account of the object of orthochromatic photography and the principles underlying its use.

WE have received reprints of an important paper by Mr. Thomas H. Holland on the Sivamalai series of elæolite-syenites and corundum-syenites in the Coimbatore district, Madras Presidency (*Mem.* Geol. Surv. India, vol. xxx. part iii., 1901). The elæolite-syenites are accompanied by augite-syenites containing olivine and other minerals. These rocks are also associated with others made up principally of felspar (albite and orthoclase), containing large quantities of well-crystallised, generally tabular, corundum, which is extracted by the villagers near the junction of the felspar-rock with the elæolite-syenite. It is remarked that the association of rocks is remarkably similar to that described in eastern Ontario, and also in the Urals.

THE methods of improving ocean bars are discussed by Mr. Lewis M. Haupt in the *Proceedings* of the American Philosophical Society for July in connection with the proposed improvements at Brunswick Outer Bar, Georgia. There are at least five methods available for creating navigable channels, namely, by the use of dynamite, by a single jetty, by a single curved breakwater, by twin jetties, and by dredging. Of the several methods proposed for bar removal by the use of single or double jetties or by the reaction breakwater, the latter, so far as it has been tested, fulfils better than any other the conflicting requirements of harbour entrances, costs less than half as much, and is far cheaper to maintain.

M. CHARLES RABOT publishes, in the August and September numbers of *La Geographie*, a full summary of the chief contributions to the literature of limnology which have appeared during the past year. The work done in each country is dealt with under a separate heading, and the paper includes a review of Prof. Forel's "Handbuch der Seenkunde."

THE *National Geographic Magazine* for September contains an article on "German Geographers and German Geography," by Dr. Martha Krug Genthe. A summary is given of the work associated with the names of Behaim, Kant, Humboldt, Ritter, Berghaus, Richthofen and Ratzel, and some account of the present position of geography in German education. The magazine also contains a note by Mr. R. Muldrow on Mount McKinley, in Alaska, the highest mountain in North America. A series of theodolite measurements from points on a stadia line run up the Shushitna River gives the position of the mountain in lat. 63° 5′ N., long. 151° 0′ W., and its height at 20,464 feet.

THE September number of *Naturen*, the excellent popular journal issued by the Bergen Museum, contains an article on the dipper, and a second on the European bison.

IN the *Memorias y Revista* "Antonio Alzate," Señor L. Herrera publishes the second instalment of his remarkable scheme for an abbreviated biological and mineralogical nomenclature.

IN the October issue of the *Zoologist* Mr. L. J. Bevir discusses Dante as a naturalist, while the Rev. H. A. Macpherson contributes some interesting particulars with regard to the work of early ornithologists.

The Zambesi Mission Record usually contains one or more articles dealing with science in a popular manner. The issue for the current month has a very readable illustrated communication entitled "A Chat about Snakes," from the pen of the Rev. J. O'Neil.

ACCORDING to the October issue of *The Naturalist*, the members of the Yorkshire Naturalists' Club enjoyed a most successful outing at Wykeham, near Scarborough, on June 22. Perhaps the feature of the day was the number of fritillary butterflies seen on the wing.

MESSRS. W. AND G. S. WEST have completed their alga-flora of Yorkshire in the *Transactions* of the Yorkshire Naturalists' Union. The enumeration makes up 1044 species.

AMONG the lectures to be delivered at the Royal Victoria Hall, Waterloo Road, during the month of November we notice the following :—November 5, "Lightning and other forms of the Electric Discharge," by Prof. A. W. Porter ; November 26, "Student Life in Germany," by Dr. A. W. Crossley.

THE syllabus of the Hampstead Scientific Society for 1901–2 has reached us, and gives promise of a full and interesting session. The opening meeting will be held on November 1, when the president, Sir Richard Temple, will deliver an address.

THOSE of our readers who are on the look-out for cheap scientific books should see the new catalogue of remainders, &c., which has just been issued by Mr. H. J. Glaisher, of Wigmore Street, W. In it are to be found the titles of very many such works at greatly reduced prices.

THE following American botanical publications have been received :—"The Willows of Alaska," by Frederick V. Colville, from the *Proceedings* of the Washington Academy of Sciences ; and the "Violet-rusts of North America," by J. C. Arthur and E. W. D. Holday, reprinted from the *Minnesota Botanical Studies*. They consist of three species, *Aecidium pedatum*, *Puccinia Violae*, and *P. effusa*.

THE *Journal* of the Royal Microscopical Society for October contains a further instalment of Mr. F. W. Millett's report on the recent foraminifera of the Malay Archipelago collected by Mr. A. Durrand. The summary of current researches is noteworthy as indicating the attention now being paid to the construction of microtomes, no less than seven new instruments or improvements on old instruments being described. Abstracts are given of a number of recently published important papers on microscopic metallography, several of them illustrated by halftone plates.

TWO papers by Ciamician and Silber have appeared in recent numbers of the *Berichte*, which describe a series of interesting experiments on the action of light in promoting mutual oxidation and reduction between organic compounds. This change is specially interesting in connection with the chemical effects brought about by light in plant life. The oxidising agent is represented by a ketone, diketone or aldehyde, those of the aromatic series being the most active. They undergo reduction into alcohol or pinacone. The reducing agent is an alcohol or ordinary ether, the alcohol being converted into aldehyde or ketone. The product of oxidation of ether has not been determined. Thus quinone dissolved in ethyl alcohol, sealed up and exposed to sunlight, gives quinol and aldehyde ; quinone and isopropyl alcohol give quinol and acetone ; glycerol is oxidised to glycerose (dioxyacetone), erythritol to erythrose, &c. On the other hand, benzophenone in presence of alcohol is reduced to benzopinacone, benzaldehyde to hydrobenzoin, &c. Curiously enough, even such stable substances as the paraffins and benzene undergo oxidation with quinone, black products being obtained, which have not yet been investigated. Still more remarkable is the action of light on ortho-nitrobenzaldehyde either dry or dissolved in various solvents. It is then converted into ortho-nitrosobenzoic acid $C_6H_4(NO_2)COH = C_6H_4(NO).COOH$. In presence of methyl or ethyl alcohol, the corresponding ester is formed. Under like conditions, meta-nitrobenzaldehyde gives resinous products, and the para-compound remains for the greater part unchanged.

THE additions to the Zoological Society's Gardens during the past week include a Ruff (*Machetes pugnax*), European, presented by Mr. W. H. Dobie ; six Common Pheasants (*Phasianus colchicus*, white var.), British, presented by Sir J. Haggerston, Bart. ; a Bronze-winged Parrot (*Pionus chalcopterus*) from Colombia, a Naked-footed Owlet (*Athene noctua*), European, deposited ; four North African Jackals (*Canis anthus*), two Fennec Foxes (*Canis cerdo*) from North Africa, received in exchange.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN NOVEMBER.

Nov. 2. 2h. 55m. to 6h. 8m. Transit of Jupiter's Sat. III.
3. 9h. 33m. Minimum of Algol (β Persei).
3. 12h. 4m. to 12h. 30m. Moon occults ω Leonis (mag. 5·6).
6. 6h. 22m. Minimum of Algol (β Persei).
9. 7h. 13m. Transit (ingress) of Jupiter's Sat. III.
10. Annular eclipse of the sun, invisible at Greenwich.
14–15. Epoch of Leonid meteoric shower (radiant 150° +22°).
15. 8h. Jupiter in conjunction with moon. Jupiter 4° 44′ S.
15. 10h. Saturn in conjunction with moon. Saturn 4° 21′ S.
15. Venus. Illuminated portion of disc = 0·591, of Mars = 0·967.
17. 18h. Venus in conjunction with Jupiter. Venus 2° 45′ S.
18. 19h. Venus in conjunction with Saturn. Venus 3° 12′ S.
20. 17h. Mercury at greatest elongation west, 19° 42′.
23. 11h. 15m. Minimum of Algol (β Persei).
24. Epoch of Andromedid meteoric shower (radiant 24° + 43°).
25. 8h. 11m. to 9h. 0m. Moon occults B.A.C. 1240 (mag. 5·7).
25. 17h. 14m. to 18h. 7m. Moon occults D.M. + 18°, 624 (mag. 5·9).
26. 8h. 4m. Minimum of Algol (β Persei).
27. 10h. 41m. to 10h. 54m. Moon occults 71 Orionis (mag. 5·1).
27. 18h. Jupiter in conjunction with Saturn. Jupiter 0° 27′ S.
28. 19h. 18m. to 20h. 6m. Moon occults 68 Geminorum (mag. 5·0).
30. 9h. 54m. to 10h. 24m. Moon occults κ Cancri (mag. 5·0).

PERIOD OF MIRA (ο CETI).—In the *Astronomische Nachrichten* (Bd. 157, No. 3745), Herr P. Guthnick classifies many of the available observations of this star, and from them deduces a mean value of the period. Sets of specially bright or faint maxima and minima are grouped together, the frequent long gaps, however, making the detailed form of the light curve somewhat uncertain. The minima may be determined from the formula

$$1883 \text{ January } 12{\cdot}09 + 331\text{d}{\cdot}3359\ E.$$

An ephemeris is given showing the predicted times of maxima and minima for the next twenty years.

Maxima		Minima
1901 July 9·0	...	1901 March 5·8
1904 March 30·2	...	1902 Jan. 31·1
1905 Feb. 25·0	...	1902 Dec. 28·5
1906 Jan. 22·4	...	1903 Nov. 24·8
1906 Dec. 19 6	...	1904 Oct. 21·2
	...	1905 Sept. 17·5
	...	1906 Aug. 14·8

THE POSSIBLE IMPROVEMENT OF THE HUMAN BREED UNDER THE EXISTING CONDITIONS OF LAW AND SENTIMENT.[1]

IN fulfilling the honourable charge that has been entrusted to me of delivering the Huxley lecture, I shall endeavour to carry out what I understand to have been the wish of its founders, namely, to treat broadly some new topic belonging to a class in which Huxley himself would have felt a keen interest, rather than to expatiate on his character and the work of his noble life.

That which I have selected for to-night is one which has occupied my thoughts for many years, and to which a large part of my published inquiries have borne a direct though silent reference. Indeed, the remarks I am about to make would serve as an additional chapter to my books on "Hereditary Genius" and on "Natural Inheritance." My subject will be the possible improvement of the human race under the existing conditions of law and sentiment. It has not hitherto been approached along the ways that recent knowledge has laid open, and it occupies in consequence a less dignified position in scientific estimation than it might. It is smiled at as most desirable in itself and possibly worthy of academic discussion, but absolutely out of the question as a practical problem. My aim in this lecture is to show cause for a different opinion. Indeed I hope to induce anthropologists to regard human improvement as a subject that should be kept openly and squarely in view, not only on account of its transcendent importance, but also because it affords excellent but neglected fields for investigation. I shall show that our knowledge is already sufficient to justify the pursuit of this perhaps the grandest of all objects, but that we know less of the conditions upon which success depends than we might and ought to ascertain. The limits of our knowledge and of our ignorance will become clearer as we proceed.

Human Variety.—The natural character and faculties of human beings differ at least as widely as those of the domesticated animals, such as dogs and horses, with whom we are familiar. In disposition some are gentle and good-tempered, others surly and vicious; some are courageous, others timid; some are eager, others sluggish; some have large powers of endurance, others are quickly fatigued; some are muscular and powerful, others are weak; some are intelligent, others stupid; some have tenacious memories of places and persons, others frequently stray and are slow at recognising. The number and variety of aptitudes, especially in dogs, is truly remarkable; among the most notable being the tendency to herd sheep, to point and to retrieve. So it is with the various natural qualities that go towards the making of civic worth in man. Whether it be in character, disposition, energy, intellect, or physical power, we each receive at our birth a definite endowment, allegorised by the parable related in St. Matthew, some receiving many talents, others few; but each person being responsible for the profitable use of that which has been entrusted to him.

Distribution of Qualities in a Nation.—Experience shows that while talents are distributed in endless different degrees, the frequency of those different degrees follows certain statistical laws, of which the best known is the Normal Law of Frequency. This is the result whenever variations are due to the combined action of many small and different causes, whatever may be the causes and whatever the object in which the variations occur, just as twice 2 always makes 4, whatever the objects may be. It therefore holds true with approximate precision for variables of totally different sorts, as, for instance, stature of man, errors made by astronomers in judging minute intervals of time, bullet marks around the bull's-eye in target practice, and differences of marks gained by candidates at competitive examinations. There is no mystery about the fundamental principles of this abstract law; it rests on such simple fundamental conceptions as, that if we toss two pence in the air they will, in the long run, come down one head and one tail twice as often as both heads or both tails. I will assume then, that the talents, so to speak, that go to the formation of civic worth are distributed with rough approximation according to this familiar law. In doing so, I in no way disregard the admirable work of Prof. Karl Pearson on the distribution of qualities, for which he was adjudged the Darwin Medal of the Royal Society a few years ago. He has amply proved that we must not blindly trust the Normal Law of Frequency; in fact, that when variations are minutely studied they rarely fall into that perfect symmetry about the mean value which is one of its consequences. Nevertheless, my conscience is clear in using this law in the way I am about to. I say that *if* certain qualities vary normally, such and such will be the results; that these qualities are of a class that are found, whenever they have been tested, to vary normally to a fair degree of approximation, and consequently we may infer that our results are trustworthy indications of real facts.

A talent is a sum whose exact value few of us care to know, although we all appreciate the inner sense of the beautiful parable. I will, therefore, venture to adapt the phraseology of the allegory to my present purpose by substituting for "talent" the words "normal-talent." The value of this normal talent in respect to each and any specified quality or faculty is such that one-quarter of the people receive for their respective shares more than one normal-talent *over and above* the average of all the shares. Our normal-talent is therefore identical with what is technically known as the "probable error." Therefrom the

[1] The second Huxley Lecture of the Anthropological Institute, delivered by Francis Galton, D.C.L., D.Sc., F.R.S., on October 29, 1901.

whole of the following table starts into life, evolved from that of the "*probability integral.*" It expresses the distribution of

TABLE I.—*Normal Distribution* (*to the nearest* per *ten-thousand and to the nearest* per *hundred*).

	−4°		−3°	−2°	−1°	M	+1°	+2°	+3°	+4°	
v and below	*u*	*t*	*s*	*r*	R	S	T	U	V and above.	Total
35	180	672	1613	2500	2500	1613	672	180	35	10,000
2		7	16	25	25	16	7	2		100

any normal quality, or any group of normal qualities, among 10,000 persons in terms of the normal-talent. The M in the upper line occupies the position of Mediocrity, or that of the average of what all have received: the $+1^\circ$, $+2^\circ$, etc., and the -1°, -2°, etc., refer to normal talents. These numerals stand as graduations at the heads of the vertical lines by which the table is divided. The entries between the divisions are the numbers per 10,000 of those who receive sums between the amounts specified by those divisions. Thus, by the hypothesis, 2500 receive more than M but less than $M+1^\circ$, 1613 receive more than $M+1^\circ$ but less than $M+2^\circ$, and so on. The terminals have only an inner limit; thus 35 receive more than 4°, some, to perhaps a very large but indefinite amount. The divisions might have been carried much farther, but the numbers in the classes between them would become less and less trustworthy. The left half of the series exactly reflects the right half. As it will be useful henceforth to distinguish these classes, I have used the *capital* or large letters R, S, T, U, V, for those above mediocrity and corresponding *italic* or small letters, *r*, *s*, *t*, *u*, *v*, for those below mediocrity, *r* being the counterpart of R, *s* of S, and so on.

In the lowest line the same values are given, but more roughly, to the nearest whole percentage.

It will assist in comprehending the values of different grades of civic worth to compare them with the corresponding grades of adult male stature in our nation. I will take the figures from my "Natural Inheritance," premising that the distribution of stature in various peoples has been well investigated and shown to be closely normal. The average height of the adult males, to whom my figures refer, was nearly 5 feet 8 inches, and the value of their "normal-talent" (which is a measure of the spread of distribution) was very nearly $1\frac{3}{4}$ inches. From these data it is easily reckoned that Class U would contain men whose heights exceed 6 feet $1\frac{1}{4}$ inches. Even they are tall enough to overlook a hatless mob, while the higher classes, such as V, W and X, tower above it in an increasingly marked degree. So the civic worth (however that term may be defined) of U-class men, and still more of V-class, are notably superior to the crowd, though they are far below the heroic order. The rarity of a V-class man in each specified quality or group of qualities is as 35 in 10,000, or say, for the convenience of using round numbers, as 1 to 300. A man of the W class is ten times rarer, and of the X class rarer still; but I shall avoid giving any more exact definition of X than as a value considerably rarer than V. This gives a general but just idea of the distribution throughout a population of each and every quality taken separately so far as it is normally distributed. As already mentioned, it does the same for *any* group of normal qualities; thus, if marks for classics and for mathematics were severally normal in their distribution, the combined marks gained by each candidate in both those subjects would be distributed normally also, this being one of the many interesting properties of the law of frequency.

Comparison of the Normal Classes with those of Mr. Booth.—Let us now compare the normal classes with those into which Mr. Charles Booth has divided the population of all London, in a way that corresponds not unfairly with the ordinary conception of grades of civic worth. He reckons them from the lowest upwards, and gives the numbers in each class for East London. Afterwards he treats all London in a similar manner, except that sometimes he combines two classes into one and gives the joint result. For my present purpose, I had to couple them somewhat differently, first disentangling them as I best could. There seemed no better way of doing this than by assigning to the members of each couplet the same proportions that they had in East London. Though this was certainly not accurate, it is probably not far wrong. Mr. Booth has taken unheard-of pains in this great work of his to arrive at accurate results, but he emphatically says that his classes cannot be separated sharply from one another. On the contrary, their frontiers blend, and this justifies me in taking slight liberties with his figures. His class A consists of criminals, semi-criminals, loafers and some others, who are in number at the rate of 1 per cent. in all London—that is 100 per 10,000, or nearly three times as many as the *v* class: they therefore include the whole of *v* and spread upwards into the *u*. His class B consists of very poor persons who subsist on casual earnings, many of whom are inevitably poor from shiftlessness, idleness or drink. The numbers in this and the A class combined closely correspond with those in *t* and all below *t*.

TABLE II.—*Comparison of Mr. Booth's Classification of All London with the Normal Classes.*

Nos.	Mr. Booth's classes.	Approx	Resorted.	Approx.	Nos.	Normal classes.
97	II. All above G	100	100	100	89	T and above
200	G. Lower middle ... ... F. High-class labour above 30*s.* per week	200	150	150	161	S
			50	250	250	R
382	E. Regular standard earnings from 22*s.* to 30*s.* per week	400	200			
			200	250	250	*r*
227	D. Regular earnings under 22*s.* per week ... ... C. Intermittent earnings, improvident, poor	200	50			
			150	150	161	*s*
94	B. Casual; very poor ... ... A. Criminals, loafers, &c.	100	100	100	89	*t* and below
1000		1000		1000	1000	

The two columns headed "Nos." give respectively the numbers per thousand in Mr. Booth's and in the normal classes.

Class C are supported by intermittent earnings; they are a hard-working people, but have a very bad character for improvidence and shiftlessness. In Class D the earnings are regular, but at the low rate of twenty-one shillings or less a week, so none of them rise above poverty, though none are very poor. D and C together correspond to the whole of *s* combined with the lower fifth of *r*. The next class, E, is the largest of any, and comprises all those with regular standard earnings of twenty-two to thirty shillings a week. This class is the recognised field for all forms of cooperation and combination; in short for trades unions. It corresponds to the upper four-fifths of *r* and the lower four-fifths of R. It is therefore essentially the mediocre class, standing as far below the highest in civic worth as it stands above the lowest class with its criminals and semi-criminals. Next above this large mass of mediocrity comes the honourable class *F*, which consists of better paid artisans and foremen. These are able to provide adequately for old age, and their sons become clerks and so forth. *G* is the lower middle class of shop-keepers, small employers, clerks and subordinate professional men, who as a rule are hard-working, energetic and sober. F and G combined correspond to the upper fifth of R and the whole of S, and are, therefore, a counterpart to D and C. All above G are put together by Mr. Booth into one class H, which corresponds to our T, U, V and above, and is the counterpart of his two lowermost classes, A and B. So far, then, as these figures go, civic worth is distributed in fair approximation to the normal law of frequency. We also see that the classes *t*, *u*, *v* and below are undesirables.

Worth of Children.—The brains of the nation lie in the higher of our classes. If such people as would be classed W or X could be distinguishable as children and procurable by money in order to be reared as Englishmen, it would be a cheap bargain for the nation to buy them at the rate of many hundred or some thousands of pounds per head. Dr. Farr, the eminent statistician, endeavoured to estimate the money worth of an average baby born to the wife of an Essex labourer and thenceforward living during the usual time and in the ordinary way of his class. Dr. Farr, with accomplished actuarial skill, capitalised the value at the child's birth of two classes of events, the one the cost of maintenance while a child and when helpless through old age, the other its earnings as boy and man. On balancing the two sides of the account the value of the baby was found to be five pounds. On a similar principle, the worth of an X-class baby would be reckoned in thousands of pounds. Some such "talented" folk fail, but most succeed, and many succeed greatly. They found great industries, establish vast undertakings, increase the wealth of multitudes and amass large fortunes for themselves. Others, whether they be rich or poor, are the guides and light of the nation, raising its tone, enlightening its difficulties and imposing its ideals. The great gain that England received through the immigration of the Huguenots would be insignificant to what she would derive from an annual addition of a few hundred children of the classes W and X. I have tried, but not yet succeeded to my satisfaction, to make an approximate estimate of the worth of a child at birth according to the class he is destined to occupy when adult. It is an eminently important subject for future investigators, for the amount of care and cost that might profitably be expended in improving the race clearly depends on its result.

Descent of Qualities in a Population.—Let us now endeavour to obtain a correct understanding of the way in which the varying qualities of each generation are derived from those of its predecessor. How many, for example, of the V class in the offspring come respectively from the V, U, T, S and other classes of parentage? The means of calculating this question for a normal population are given fully in my "Natural Inheritance." There are three main senses in which the word parentage might be used. They differ widely, so the calculations must be modified accordingly. (1) The amount of the quality or faculty in question may be known in each parent. (2) It may be known in only one parent. (3) The two parents may belong to the same class, a V-class father in the scale of male classification always marrying a V-class mother, occupying identically the same position in the scale of female classification.

I select this last case to work out as being the one with which we shall here be chiefly concerned. It has the further merit of escaping some tedious preliminary details about converting female faculties into their corresponding male equivalents, before men and women can be treated statistically on equal terms. I shall assume in what follows that we are dealing with an ideal population, in which all marriages are equally fertile, and which is statistically the same in successive generations both in numbers and in qualities, so many per cent. being always this, so many always that, and so on. Further, I shall take no notice of offspring who die before they reach the age of marriage, nor shall I regard the slight numerical inequality of the sexes, but will simply suppose that each parentage produces one couplet of grown-up filials, an adult man and an adult woman.

The result is shown to the nearest whole per thousand in the diagram up to "U and above," and in the table up to "V and

TABLE III.—*Descent of Qualities in a Population.* (*The difference between the sexes only affects the value of the Unit of the Scale of Distribution*).

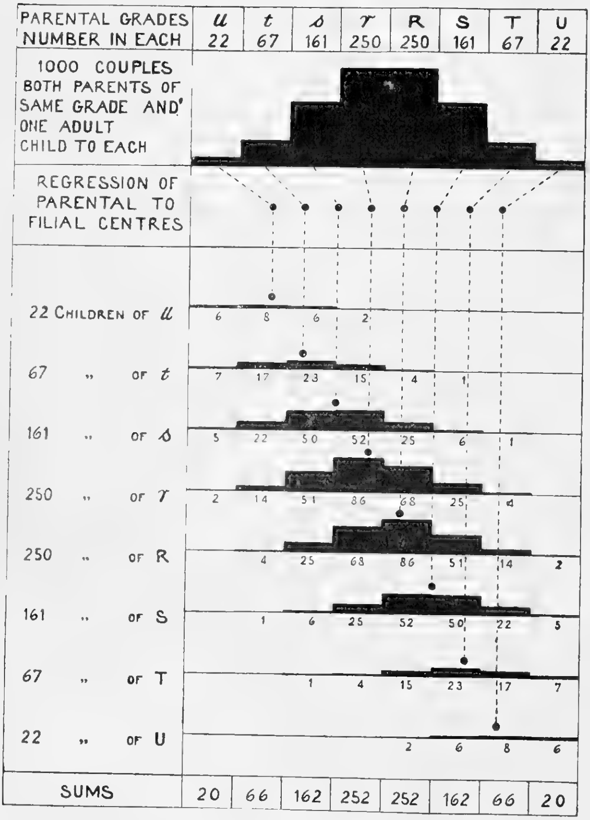
Conditions.—(1) Parents to be always alike in class, (2) Statistics of population to continue unchanged, (3) Normal Law of Frequency to be applicable throughout.

Per 100 Fathers (or *Mothers*).	2		7	16	25	25	16	7	2		100
Per 10,000 ,, ,,	35	180	671	1614	2500	2500	1614	672	180	35	10,000
Names of classes	*v*	*u*	*t*	*s*	*r*	R	S	T	U	V	Totals
											Sons (or *daughters*).
Sons / *Daughters* of 35 Fathers / *Mothers* of class V ...						1	6	12	10	6	35
,, 180 ,, ,, U ...					4	20	52	61	33	10	180
,, 671 ,, ,, T ...				7	44	150	234	170	57	10	672
,, 1614 ,, ,, S ...			6	57	253	512	509	224	47	5	1613
,, 2500 ,, ,, R ..		3	42	248	678	860	510	140	18	3	2502
,, 2500 ,, ,, *r* ..	3	18	140	510	860	678	248	42	3		2502
,, 1614 ,, ,, *s* ...	5	47	224	509	512	253	57	6			1613
,, 671 ,, ,, *t* ...	10	57	170	234	150	44	7				672
,, 180 ,, ,, *u* ...	10	33	61	52	20	4					180
,, 35 ,, ,, *v* ...	6	10	12	6	1						35
Total 10,000 Fathers (or *Mothers*)	34	168	655	1623	2522	2522	1623	655	168	34	10,004
,, 100 ,, ,, ...	2		7	16	25	25	16	7	2		

Note.—The agreement in distribution between fathers (or *mothers*) and sons (or *daughters*) is exact to the nearest whole per centage. The slight discrepancy in the ten-thousandths is mainly due to the classes being too few and too wide; theoretically they should be extremely numerous and narrow.

above," to the nearest ten-thousandth. They may be read either as applying to fathers and their sons when adult, or to mothers and their daughters when adult, or, again, to parentages and filial couplets. I will not now attempt to explain the details of the calculation to those to whom these methods are new. Those who are familiar with them will easily understand the exact process from what follows. There are three points of reference in a scheme of descent which may be respectively named "mid-parental," "genetic" and "filial" centres. In the present case of both parents being alike, the position of the mid-parental centre is identical with that of either parent separately. The position of the filial centre is that from which the children disperse. The genetic centre occupies the same position in the parental series that the filial centre does in the filial series. "Natural Inheritance" contains abundant proof, both observational and theoretical, that the genetic centre is not and cannot be identical with the parental centre, but is always more mediocre, owing to the combination of ancestral influences—which are generally mediocre—with the purely parental ones. It also shows that the regression from the parental to the genetic centre, in the case of stature at least, would amount to two-thirds under the conditions we are now supposing. The regression is indicated in the diagram by converging lines which are directed towards the same point below, but are stopped at one-third of the distance on the way to it. The contents of each parental class are supposed to be concentrated at the foot of the median axis of that class, this being the vertical line that divides its contents into equal parts. Its position is approximately, but not exactly, half-way between the divisions that bound it, and is as easily calculated for the extreme classes, which have no outer terminals, as for any of the others. These median points are respectively taken to be the positions of the parental centres of the whole of each of the classes; therefore the positions attained by the converging lines that proceed from them at the points where they are stopped, represent the genetic centres. From these the filials disperse to the right and left with a "spread" that can be shown to be three-quarters that of the parentages. Calculation easily determines the number of the filials that fall into the class in which the filial centre is situated, and of those that spread into the classes on each side. When the parental contributions from all the classes to each filial class are added together they will express the distribution of the quality among the whole of the offspring. Now it will be observed in the table that the numbers in the classes of the offspring are identical with those of the parents, when they are reckoned to the nearest whole percentage, as should be the case according to the hypothesis. Had the classes been narrower and more numerous, and if the calculations had been carried on to two more places of decimals, the correspondence would have been identical to the nearest ten-thousandth. It was unnecessary to take the trouble of doing this, as the table affords a sufficient basis for what I am about to say. Though it does not profess to be more than approximately true in detail, it is certainly trustworthy in its general form, including as it does the effects of regression, filial dispersion, and the equation that connects a parental generation with a filial one when they are statistically alike. Minor corrections will be hereafter required, and can be applied when we have a better knowledge of the material. In the meantime it will serve as a standard table of descent from each generation of a people to its successor.

STANDARD SCHEME OF DESCENT



Economy of Effort.—I shall now use the table to show the economy of concentrating our attention upon the highest classes. We will therefore trace the origin of the V class—which is the highest in the table. Of its 34 or 35 sons, 6 come from V parentages, 10 from U, 10 from T, 5 from S, 3 from R, and none from any class below R. But the numbers of the contributing parentages have also to be taken into account. When this is done, we see that the lower classes make their scores owing to their quantity and not to their quality; for while 35 V-class parents suffice to produce 6 sons of the V class, it takes 2500 R-class fathers to produce 3 of them. Consequently the richness in produce of V-class parentages is to that of the R-class in an inverse ratio, or as 143 to 1. Similarly, the richness in produce of V-class children from parentages of the classes U, T, S, respectively, is as 3, 11½ and 55, to 1. Moreover, nearly one-half of the produce of V-class parentages are V or U taken together, and nearly three-quarters of them are either V, U or T. If then we desire to increase the output of V-class offspring, by far the most profitable parents to work upon would be those of the V class, and in a threefold less degree those of the U class.

When both parents are of the V class the quality of parentages is greatly superior to those in which only one parent is a

V. In that case the regression of the genetic centre goes twice as far back towards mediocrity, and the spread of the distribution among filials becomes nine-tenths of that among the parents, instead of being only three-quarters. The effect is shown in Table IV.

TABLE IV.—*Distribution of Sons.* (1) *One parent of class* V., *the other unknown.* (2) *Both parents of class* V (*from Table II., with decimal point and an* 0).

	Distribution of Sons								Total
	t	*s*	*r*	R	S	T	U	V	
One V-parent ...	0·3	1·2	3·5	7·9	9·6	7·5	3·6	1·3	34·3
Two V-parents				3·0	5·0	10·0	10·0	6·0	34·0

Position of the filial centre of (1) = 1·44, of (2) = 2·89. When both parents are T it = 1·58.

There is a difference of fully two divisions in the position of the genetic centre, that of the single V parentage being only a trifle nearer mediocrity than that of the double T. Hence it would be bad economy to spend much effort in furthering marriages with a high class on only one side.

Marriage of Like to Like.—In each class of society there is a strong tendency to intermarriage, which produces a marked effect in the richness of brain power of the more cultured families. It produces a still more marked effect of another kind at the lowest step of the social scale, as will be painfully evident from the following extracts from the work of Mr. C. Booth (i. 38), which refer to his Class A, who form, as has been said, the lowermost third of our "*v* and below." "Their life is the life of savages, with vicissitudes of extreme hardship and occasional excess. From them come the battered figures who slouch through the streets and play the beggar or the bully. They render no useful service, they create no wealth; more often they destroy it. They degrade whatever they touch, and as individuals are perhaps incapable of improvement . . . but I do not mean to say that there are not individuals of every sort to be found in the mass. Those who are able to wash the mud may find some gems in it. There are at any rate many very piteous cases. Whatever doubt there may be as to the exact numbers of this class, it is certain that they bear a very small proportion to the rest of the population, or even to Class B, with which they are mixed up and from which it is at times difficult to separate them. . . . They are barbarians, but they are a handful. . . ." He says further, "It is much to be desired and to be hoped that this class may become less hereditary in its character; there appears to be no doubt that it is now hereditary to a very considerable extent."

Many who are familiar with the habits of these people do not hesitate to say that it would be an economy and a great benefit to the country if all habitual criminals were resolutely segregated under merciful surveillance and peremptorily denied opportunities for producing offspring. It would abolish a source of suffering and misery to a future generation, and would cause no unwarrantable hardship in this.

Diplomas.—It will be remembered that Mr. Booth's classification did not help us beyond classes higher than S in civic worth. If a strong and widely felt desire should arise, to discover young men whose position was of the V, W or X order, there would not be much difficulty in doing so. Let us imagine, for a moment, what might be done in any great University, where the students are in continual competition in studies, in athletics, or in public meetings, and where their characters are publicly known to associates and to tutors. Before attempting to make a selection, acceptable definitions of civic worth would have to be made in alternative terms, for there are many forms of civic worth. The number of men of the V, W or X classes whom the University was qualified to contribute annually must also be ascertained. As was said, the proportion in the general population of the V class to the remainder is as 1 to 300, and that of the W class as 1 in 3000. But students are a somewhat selected body because the cleverest youths, in a scholastic sense, usually find their way to Universities. A considerably high level, both intellectually and physically, would be required as a qualification for candidature. The limited number who had not been automatically weeded away by this condition might be submitted in some appropriate way to the independent votes of fellow-students on the one hand, and of tutors on the other, whose ideals of character and merit necessarily differ. This ordeal would reduce the possible winners to a very small number, out of which an independent committee might be trusted to make the ultimate selection. They would be guided by personal interviews. They would take into consideration all favourable points in the family histories of the candidates, giving appropriate hereditary weight to each. Probably they would agree to pass over unfavourable points, unless they were notorious and flagrant, owing to the great difficulty of ascertaining the real truth about them. Ample experience in making selections has been acquired even by scientific societies, most of which work well, including perhaps the award of their medals, which the fortunate recipients at least are tempted to consider judicious. The opportunities for selecting women in this way are unfortunately fewer, owing to the smaller number of female students between whom comparisons might be made on equal terms. In the selection of women, when nothing is known of their athletic proficiency, it would be especially necessary to pass a high and careful medical examination; and as their personal qualities do not usually admit of being tested so thoroughly as those of men, it would be necessary to lay all the more stress on hereditary family qualities, including those of fertility and prepotency.

Correlation between Promise in Youth and subsequent Performance.—No serious difficulty seems to stand in the way of classifying and giving satisfactory diplomas to youths of either sex, supposing there were a strong demand for it. But some real difficulty does lie in the question—Would such a classification be a trustworthy forecast of qualities in later life? The scheme of descent of qualities may hold good between the parents and the offspring at similar ages, but that is not the information we really want. It is the descent of qualities from men to men, not from youths to youths. The accidents that make or mar a career do not enter into the scope of this difficulty. It resides entirely in the fact that the development does not cease at the time of youth, especially in the higher natures, but that faculties and capabilities which were then latent subsequently unfold and become prominent. Putting aside the effects of serious illness, I do not suppose there is any risk of retrogression in capacity before old age comes on. The mental powers that a youth possesses continue with him as a man; but other faculties and new dispositions may arise and alter the balance of his character. He may cease to be efficient in the way of which he gave promise, and he may perhaps become efficient in unexpected directions.

The correlation between youthful promise and performance in mature life has never been properly investigated. Its measurement presents no greater difficulty, so far as I can foresee, than in other problems which have been successfully attacked. It is one of those alluded to in the beginning of this lecture as bearing on race-improvement, and being on its own merits suitable for anthropological inquiry. Let me add that I think its neglect by the vast army of highly educated persons who are connected with the present huge system of competitive examinations to be gross and unpardonable. Neither schoolmasters, tutors, officials of the Universities, nor of the State department of education, have ever to my knowledge taken any serious step to solve this important problem, though the value of the present elaborate system of examinations cannot be rightly estimated until it is solved. When the value of the correlation between youthful promise and adult performance shall have been determined, the figures given in the table of descent will have to be reconsidered.

Augmentation of Favoured Stock.—The possibility of improving the race of a nation depends on the power of increasing the productivity of the best stock. This is far more important than that of repressing the productivity of the worst. They both raise the average, the latter by reducing the undesirables, the former by increasing those who will become the lights of the nation. It is therefore all important to prove that favour to selected individuals might so increase their productivity as to warrant the expenditure in money and care that would be necessitated. An enthusiasm to improve the race would probably express itself by granting diplomas to a select class of young men and women, by encouraging their intermarriages, by hastening the time of marriage of women of that high class, and by provision for rearing children healthily. The means that might be employed to compass these ends are dowries, especially for those to whom moderate sums are important, assured help in emergencies during the early years of married life, healthy homes, the pressure of public opinion, honours, and above all the introduction of motives of religious or quasi-religious character. Indeed, an enthusiasm to improve the race is so noble in its aim that it might well give rise to the sense of a religious obligation. In other lands there are abundant instances in which religious motives make early marriages a matter of custom, and continued celibacy to be regarded as a disgrace, if not a crime. The customs of the Hindoos, also of the Jews, especially in ancient times, bear this out. In all costly civilisations there is a tendency to shrink from marriage on prudential grounds. It would, however, be possible so to alter the conditions of life that the most prudent course for an X class person should lie exactly opposite to its present direction, for he or she might find that there were advantages and not disadvantages in early marriage, and that the most prudent course was to follow their natural instincts.

We have now to consider the probable gain in the number and worth of adult offspring to these favoured couples. First as regards the effect of reducing the age at marriage. There is unquestionably a tendency among cultured women to delay or even to abstain from marriage; they dislike the sacrifice of freedom and leisure, of opportunities for study and of cultured companionship. This has to be reckoned with. I heard of the reply of a lady official of a College for Women to a visitor who inquired as to the after life of the students. She answered that one-third profited by it, another third gained little good, and a third were failures. "But what becomes of the failures?" "Oh, hey marry."

There appears to be a considerable difference between the earliest age at which it is physiologically desirable that a woman should marry and that at which the ablest, or at least the most cultured, women usually do. Acceleration in the time of marriage, often amounting to 7 years, as from 28 or 29 to 21 or 22, under influences such as those mentioned above, is by no means improbable. What would be its effect on productivity? It might be expected to act in two ways:—

(1) By shortening each generation by an amount roughly proportionate to the diminution in age at which marriage occurs. Suppose the span of each generation to be shortened by one-sixth, so that six take the place of five, and that the productivity of each marriage is unaltered, it follows that one-sixth more children will be brought into the world during the same time, which is, roughly, equivalent to increasing the productivity of an unshortened generation by that amount.

(2) By saving from certain barrenness the earlier part of the child-bearing period of the woman. Authorities differ so much as to the direct gain of fertility due to early marriage that it is dangerous to express an opinion. The large and thriving families that I have known were the offspring of mothers who married very young.

The next influence to be considered is that of healthy homes. These and a simple life certainly conduce to fertility. They also act indirectly by preserving lives that would otherwise fail to reach adult age. It is not necessarily the weakest who perish in this way, for instance, zymotic disease falls indiscriminately on the weak and the strong.

Again, the children would be healthier and therefore more likely in their turn to become parents of a healthy stock. The great danger to high civilisations, and remarkably so to our own, is the exhaustive drain upon the rural districts to supply large towns. Those who come up to the towns may produce large families, but there is much reason to believe that these dwindle away in subsequent generations. In short, the towns sterilise rural vigour.

As one of the reasons for choosing the selected class would be that of hereditary fertility, it follows that the selected class would respond more than other classes to the above influences.

I do not attempt to appraise the strength of the combined six influences just described. If each added one-sixth to the produce the number of offspring would be doubled. This does not seem impossible considering the large families of colonists, and of those in many rural districts; but it is a high estimate. Perhaps the fairest approximation may be that these influences would cause the X women to bring into the world an average of one adult son and one adult daughter *in addition* to what they would otherwise have produced. The table of descent applies to one son or to one daughter per couple; it may now be read as specifying the net gain and showing its distribution. Should this estimate be thought too high, the results may be diminished accordingly.

It is no absurd idea that outside influences should hasten the age of marrying and make it customary for the best to marry the best. A superficial objection is sure to be urged that the fancies of young people are so incalculable and so irresistible that they cannot be guided. No doubt they are so in some exceptional cases. I lately heard from a lady who belonged to a county family of position that a great aunt of hers had scandalised her own domestic circle two generations ago by falling in love with the undertaker at her father's funeral and insisting on marrying him. Strange vagaries occur, but considerations of social position and of fortune, with frequent opportunities of intercourse, tell much more in the long run than sudden fancies that want roots. In a community deeply impressed with the desire of encouraging marriages between persons of equally high ability, the social pressure directed to produce the desired end would be so great as to ensure a notable amount of success.

Profit and Loss.—The problem to be solved now assumes a clear shape. A child of the X class (whatever X signifies) would have been worth so and so at its birth, and one of each of the other grades respectively would have been worth so and so; 100 X parentages can be made to produce a net gain of 100 adult sons and 100 adult daughters who will be distributed among the classes according to the standard table of descent. The total value of the prospective produce of the 100 parentages can then be estimated by an actuary, and consequently the sum that it is legitimate to spend in favouring an X parentage. The clear and distinct statement of a problem is often more than half way towards its solution. There seems no reason why this one should not be solved between limiting values that are not too wide apar to be useful.

Existing Activities.—Leaving aside profitable expenditure from a purely money point of view, the existence should be borne in mind of immense voluntary activities that have nobler aims. The annual voluntary contributions in the British Isles to public charities alone amount, on the lowest computation, to fourteen million pounds, a sum which Sir H. Burdett asserts on good grounds is by no means the maximum obtainable. ("Hospitals and Charities," 1898, p. 85.)

There are other activities long since existing which might well be extended. I will not dwell, as I am tempted to do, on the endowments of scholarships and the like, which aim at finding and educating the fittest youths for the work of the nation; but I will refer to that wholesome practice during all ages of wealthy persons interesting themselves in and befriending poor but promising lads. The number of men who have owed their start in a successful life to help of this kind must have struck every reader of biographies. This relationship of befriender and befriended is hardly to be expressed in English by a simple word that does not connote more than is intended. The word "patron" is odious. Recollecting Dr. Johnson's abhorrence of the patrons of his day, I turned to an early edition of his dictionary in hope of deriving some amusement as well as instruction from his definition of the word, and I was not disappointed. He defines "patron" as "a wretch who supports with insolence and is repaid with flattery." That is totally opposed to what I would advocate, namely a kindly and honourable relation between a wealthy man who has made his position in the world and a youth who is avowedly his equal in natural gifts, but who has yet to make it. It is one in which each party may well take pride, and I feel sure that if its value were more widely understood it would become commoner than it is.

Many degrees may be imagined that lie between mere befriendment and actual adoption, and which would be more or less effective in freeing capable youths from the hindrances of narrow circumstances; in enabling girls to marry early and suitably, and in securing favour to their subsequent offspring. Something in this direction is commonly but half unconscioully done by many great landowners whose employments for man and wife, together with good cottages, are given to exceptionally deserving couples. The advantage of being connected with a great and liberally managed estate being widely appreciated, there are usually more applicants than vacancies, so selection can be exercised. The consequence is that the class of men found upon these properties is markedly superior to those in similar positions elsewhere. It might well become a point of honour, and as much an avowed object, for noble families to gather fine specimens of humanity around them, as it is to procure and maintain fine breeds of cattle and so forth, which are costly, but repay in satisfaction.

There is yet another existing form of princely benevolence which might be so extended as to exercise a large effect on race improvement. I mean the provision to exceptionally promising young couples of healthy and convenient houses at low rentals. A continually renewed settlement of this kind can be easily imagined, free from the taint of patronage, and analogous to colleges with their self-elected fellowships and rooms for residence, that should become an exceedingly desirable residence for a specified time. It would be so in the same way that a good club by its own social advantages attracts desirable candidates. The tone of the place would be higher than elsewhere, on account of the high quality of the inmates, and it would be distinguished by an air of energy, intelligence, health and self-respect and by mutual helpfulness.

Prospects.—It is pleasant to contrive Utopias, and I have indulged in many, of which a great society is one, publishing intelligence and memoirs, holding yearly elections, administering large funds, establishing personal relations like a missionary society with its missionaries, keeping elaborate registers and discussing them statistically with honest precision. But the first and pressing point is to thoroughly justify any crusade at all in favour of race improvement. More is wanted in the way of unbiased scientific inquiry along the many roads I have hurried over, to make every stepping-stone safe and secure, and to make it certain that the game is really worth the candle. All I dare hope to effect by this lecture is to prove that in seeking for the improvement of the race we aim at what is apparently possible to accomplish, and that we are justified in following every path in a resolute and hopeful spirit that seems to lead towards that end. The magnitude of the inquiry is enormous, but its object is one of the highest man can accomplish. The faculties of future generations will necessarily be distributed according to laws of heredity, whose statistical effects are no longer vague, for they are measured and expressed in formulæ. We cannot doubt the existence of a great power ready to hand and capable of being directed with vast benefit as soon as we shall have learnt to understand and to apply it. To no nation is a high human breed more necessary than to our own, for we plant our stock all over the world and lay the foundation of the dispositions and capacities of future millions of the human race.

OCEAN CIRCULATION.[1]

THE investigation carried on by Mr. H. N. Dickson into the distribution of temperature and salinity in the surface water of the North Atlantic is one of great importance. It promises, if continued, to be of considerable value, not only to those who are especially interested in studying the circulation of the surface water of the Ocean, but also to meteorologists generally and particularly to those who see, in a comparison of the varying yearly temperatures of the North Atlantic with that of a mean for the season, the key to a clearer knowledge of the causes which combine to influence the climate of western Europe, and especially of our Islands, and who look hopefully in that direction for information whereby future modifications in the conditions of climate may be foretold for periods some time in advance.

The treatise before us, setting forth the author's method of conducting the research and the results at which he arrived, was contributed to the Royal Society in March, 1900.

In introducing his subject the author says: "The history of our knowledge of the currents of the North Atlantic Ocean up to the year 1870 has been written once for all by Petermann," whom he quotes at some length, remarking "that the conclusions, then arrived at, were not modified by the observations of the next twenty years."

During the years 1896 and 1897 materials were collected for preparing the charts of temperature and salinity, the parallel of 40° N. being selected as the southern boundary of the area for investigation. The observations of temperature were furnished by the Meteorological Office, the Danish Meteorological Department, the United States Hydrographical Department, and the Bureau Central Météorologique de France, and by Prof. Pettersson. The samples of water for the determination of salinity were obtained from the captains of vessels keeping logs for the Meteorological Office and for the Danish Hydrographical Department, specially made bottles being supplied to them for the purpose, and no care being spared in guarding against impurity or the introduction of any matter that could give rise to error in the analytical determinations.

The accuracy of the method adopted in estimating the salinity of the samples was subjected to severe scrutiny. The author states the results of his observations, demonstrating the distribution of temperature and salinity for each month during the year 1896 as shown in the charts prepared by him, in which the isotherms and isohalines are supplemented by a scale of colouring denoting areas having the same range of temperature and the same range of salinity. He calls attention to the general agreement between the distribution of salinity as shown on the one set of charts and that of temperature as shown on the other set when apparent, and notes departures and irregularities when they occur. He then deals in the same manner with the observations of 1897 and compares results.

Taking the means of each month respectively for the two years, the distribution of temperature, as shown on these charts, corresponds fairly well with the distribution of sea-surface temperature given on the quarterly sea-temperature charts on the North Atlantic, issued by the Meteorological Office in 1884.

For the purpose of defining the limits of ocean currents and of arriving at some estimate as to its relative velocity in different localities, the information to be gained by the thermometer is invaluable, for over areas little frequented by shipping where current observations are necessarily sparse, a comparatively insignificant number of sea-surface observations will suffice to indicate the existence or failure of an ocean stream; and if to these detective signs be added observations of salinity, the evidence acquired becomes still more complete.

The effects of the cold water from the north in deflecting the warm stream from the westward are clearly shown on these charts, which, when seasonal variation in temperature has been made allowance for, appear in good agreement (speaking generally) with the monthly current charts of the North Atlantic, published by the Admiralty, as regards the area over which the warm water of the Gulf Stream is distributed each month, and the northern and western limits to which it reaches. The indications of the existence of Gulf Stream water, stated roughly, may be traced on the Admiralty Chart to the following limits in the given months:—

January.—The stream does not reach to the eastward of 20° W., and a south-easterly set is apparent off Ireland.

February.—In 55° N. it reaches 15° W.; a south-easterly set is found to the westward of Ireland, and a south-westerly to the south-westward of the Fastnet Rock.

March.—It has advanced to the coast of Ireland.

April.—In 55° N. its limit has receded to 20° W., and the Iceland south-going current begins to show itself north of 55° N.

May.—The Gulf Stream and Davies Strait cold current commingle in 47° N. 27° W., the Iceland current sets S. and S.W. to 48° N. 30° W.

June.—Gulf Stream to 15° W. in 52° N. Iceland and Denmark Strait cold currents to Irish coast.

July.—To the S. of 50° N. it joins the Iceland and Denmark Strait current in about 48° N. off the Bay of Biscay.

August.—It extends to the north of Ireland but is modified in about 20° W. by a south-going set.

September.—It extends to the north of Scotland.

October.—It is found in 10° W. in 59° N.

November.—The data are insufficient, but the Stream is traceable to 19° W. in 59° N.

December.—It is difficult to trace the Stream eastward of 40° N. in 45° W. A south-going cold current is shown to the north-westward and westward of Ireland; there is a persistent southerly (S.E. to S.W.) movement of water in the eastern half of the Atlantic.

Mr. Dickson's charts show the existence of Gulf Stream water to the northward and westward of the limits given above for several months, notably on the January chart, and the explanation doubtless is that the value of the current being small, it has been inappreciable in navigation.

There exists, during the greater part of the year, a movement of water eastward, which divides, at a varying distance to the westward of the English Channel. One arm branches towards the Bay of Biscay, the other northward (Rennell's Current). The latter is well known to the captains of the large

[1] *Phil. Trans.* of the Royal Society:—"The Circulation of the Surface Waters of the North Atlantic Ocean." By H. N. Dickson.

Transatlantic liners, who are accustomed to make allowance for it when shaping their course to sight the Fastnet. This current is well shown on the author's temperature charts for several months.

In dealing with the question of causation, the author summarises as follows: "The general circulation of the North Atlantic is therefore the result of a large number of factors, each of which is subject to wide variation. From a consideration of the mean results in its relation to the mean atmospheric circulation, it appears that the oceanic circulation is directly controlled by the winds, the form, position and intensity of the whole Atlantic anticyclone and of the cyclonic area to the north of it being taken into account. The movements of water set up directly by these systems are modified by, firstly and chiefly, the configuration of the land, and, secondly, by the effects of melting ice." And again: "The key to the position seems to be the Atlantic anticyclone which controls the low-pressure areas, both directly and indirectly, by its far-reaching effect on the oceanic circulation; and it seems scarcely likely that the causes modifying this system are confined to the Atlantic, even if they are to be found at the surface at all."

It would be regrettable if this work, so ably and successfully inaugurated, should be dropped.

Mr. Dickson mentions that it can be efficiently carried on for the sum of 300*l.* annually, and we are of opinion that the cost might be even less, for on board of almost all large liners the temperature of the sea surface is recorded at intervals of four hours with regularity, and on many, observations for specific gravity also; the rough method by which the latter is obtained is, we admit, unsatisfactory, as the hydrometer is difficult to read when subject to the least movement, but these records are better than none. In the interests of navigation alone this investigation should be continued.

It is noteworthy that, at the present time, there are many navigators who, in some measure, utilise observations of sea-surface temperature, and the time is not, we hope, far distant when the sea-surface thermometer and hydrometer may be recognised generally, as aids in determining to some extent changes in the direction and strength of ocean currents, and as affording the seaman an additional safeguard against miscalculation when approaching land in thick weather.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Natural science scholarships are announced for competition at Balliol, Christchurch and Trinity on December 3, at Magdalen on December 10, at Jesus on January 14.

Dr. J. S. Haldane, lecturer in physiology, has been elected to a fellowship at New College.

Dr. G. C. Bourne has been re-appointed lecturer in comparative anatomy for a period of three years.

Mr. O. J. R. Howarth, of Christ Church, has been elected to the geographical scholarship.

The celebration of the tercentenary of Bodley's Library will take place in October, 1902, and a delegacy of twelve will shortly be appointed to undertake the necessary arrangements.

The 227th meeting of the Oxford University Junior Scientific Club was held (Wednesday, October 23) at the Museum. The principal business of the evening was a paper by H. S. Souttar, of Queen's College, entitled "The Atom, an Electromagnetic Theory of Matter." The principal officers of the Club for this term are:—president, A. C. le Rossignol, Exeter; treasurer, E. L. Kennaway, New College; chemical secretary, E. Walls, Corpus; biological secretary, E. Burstal, Trinity; Boyle Lecture treasurer, S. A. Ionides, Balliol; editor, H. D. Davis, Balliol; members of committee, J. G. Priestley, Christ Church; Rev. G. D. Allen, non-collegiate.

CAMBRIDGE:—Mr. H. Lamb, Trinity, Mr. J. Larmor, St. John's, Mr. H. W. Richmond, King's, and Mr. E. T. Whittaker, Trinity, have been appointed examiners for the Mathematical Tripos, part 2, to be held in 1902.

Mr. W. T. N. Spivey, of Trinity College, died on October 22 from septic pneumonia following a lamentable accident which happened to him in the University Chemical Laboratory a fortnight before. Mr. Spivey was engaged in research work and was shaking two volatile and explosive liquids in a flask when an explosion occurred and he was seriously cut and burned. The sad death of this promising young chemist is much regretted.

DR. R. THAXTER has been appointed professor of cryptogamic botany at Harvard University.

AT a meeting of the Royal University of Ireland held on Friday last, the degree of D.Sc. was conferred upon Prof. W. N. Hartley, F.R.S.

A NEW Hall of Natural History is to be erected in connection with Syracuse University at the expense of an anonymous donor.

MR. F. E. REES, lecturer in physics at the Storey Institute, Lancaster, has been appointed to the lectureship and demonstratorship of physics at the University College of North Wales, Bangor.

Science states that Milliken University, Decatur, Ill., will be opened next year with an endowment of more than a million dollars, half of which sum has been given by Mr. James Milliken. Prof. S. R. Taylor, late of the Kansas State Normal School, has been appointed the president.

ADDITIONAL examiners in mathematics, chemistry, zoology, materia medica and therapeutics, medicine and clinical medicine, surgery and clinical surgery will shortly be appointed by the University of Glasgow. Applications for the appointments must be lodged on or before December 3 next.

A CIRCULAR just issued by the Board of Education describes the principles which are being followed with regard to making grants to schools and classes conducted by School Boards under the provisions of the new Education Act. When the local Authority has given a general sanction to the work of an existing school, the school is eligible for grants upon subjects taught in the twelve months preceding the passing of the Act. Extensions of the curriculum, or of the work of a school by including pupils of an age or sex not previously admitted, will not be recognised unless the specific sanction of the Local Authority has been furnished to the Board of Education.

ACCORDING to *Science*, the attendance at Cornell University, including 850 new students, is about 250 in excess of that of last year. Inclusive of the medical school in New York and the summer school at Ithaca, the total registration for the year is between 3250 and 3500. The registration on the campus, of students in regular courses, promises to be about 2750. Sibley College has a total attendance of new students, in all classes and courses, of above 350, almost equal to the total of upper classmen returning to the college, making the probable total registration for 1901–2 about 750 in all grades. The College of Civil Engineering has inceased fifty per cent., and the other colleges and departments report large additions.

THE Hon. T. Jefferson Coolidge, of Boston, has given more than 50,000 dollars to the Jefferson Physical Laboratory of Harvard University to further physical research. In the terms of the gift he states that:—"The income of this fund shall be used primarily for laboratory expenses of original investigations by members of the laboratory staff. But the Director, at his discretion, may award therefrom an honorarium, of not more than five hundred dollars per annum, for the private use of any person who—although receiving no salary from the University—may wish to carry on original investigations under his directions at the Jefferson Laboratory. The results of such investigations shall appertain to the Laboratory, and the name of the Laboratory shall accompany the investigation; but no publication shall be made without the approval of the Director. The balance of this income is to be used only for meeting the legitimate expenditures of original investigations whether by professors or students."

IN introducing Mr. James Stuart, the Lord Rector of St. Andrews University, to the gathering held at Dundee on Friday, October 25, Lord Balfour of Burleigh, the newly-elected Chancellor of the University, remarked that it was said that trade was being taken away from the country, that German chemistry had deprived Britain of the indigo trade, that we had to go to other countries for our goods, and that, generally speaking, trade in this country was in a bad way. The British manufacturer depended upon old methods, while the German employed newer. It was their business to help the manufacturers of this country to put an end to this. What was wanted in Dundee was a greater subdivision of subjects. They wanted a chair of geology and much more subdivision in the different branches of chemistry, and, first and foremost, a chair of the German language and literature. More teaching power was required and more space in which that power might exercise itself.

THE installation of Lord Balfour of Burleigh as Chancellor of the University of St. Andrews, in succession to the late Duke of Argyll, was made the occasion of a series of brilliant functions in the ancient city last week. The address delivered by Lord Balfour after his installation dealt with several important aspects of higher education, and his statement of the relationship between national progress and scientific research should be of value in showing that the work done in a progressive University is technical training of the highest kind. Referring to University studies, Lord Balfour remarked, "Besides the broad general treatment of any scientific course, the University should be enabled, as a sequel to that course, to specialise in the more advanced stages of scientific training and to encourage original research on particular lines. For this purpose the University must have full equipment and must be furnished with teachers of special attainments, who will direct and guide that original research. The students will pursue the subject as a University study, and with the view of enlarging and advancing the knowledge of their special subject. In this way only can a real advance in scientific knowledge be made; and from the students who pursue these courses—generally, I would say, post-graduate courses—we must look for the enlargement of scientific knowledge, and amongst them or as the products of their efforts we may find pioneers in the application of truly scientific method to our manufactures. A modern University must deal with the principles which lie at the root of our commercial relations, and upon which the development of manufactures must rest, just as much as it does with the principles of philology and mental philosophy. Our commercial, no less than our educational position, must be supported by a thorough training, by careful attention to principles and by imparting to young men who are to pursue commercial pursuits the power of grasping the wider aspects of the questions with which they will have to deal, and by taking care that while they obtain a training fitted to be of practical value to them in their after life, that training shall be such as will really awaken their intelligence and enable them to cultivate the inestimable qualities of judgment, of foresight and of enterprise." Upon this subject scientific and practical men are in agreement, and the demand will be met, as Lord Balfour remarked, not by curtailing the work of the Universities, or by lowering in any way their standard of scholarship or of pure science, but by enlarging their borders and extending their influence.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, October 25.—Prof. S. P. Thompson, president, in the chair.—A paper on the variation with temperature of the thermoelectromotive force and of the electric resistance of nickel, iron and copper between the temperatures of − 200° and + 1050° was read by Mr. E. P. Harrison. In this paper the changes with temperature of the thermoelectromotive force and the resistance of nickel and iron are traced over a wide range and the singularities present in the curves representing these changes are investigated. In all experiments the same specimens of metal were used. Previous work on this subject has been performed by Tait, Fleming and Dewar, Holborn and Day, and Stansfield. In the author's experiments on E.M.F. an ordinary potentiometer method was used, the potential difference due to the thermocouple being balanced against a portion of that due to two accumulators. Before each reading a standard cadmium cell was balanced on a definite resistance in the accumulator circuit. Readings of E.M.F. of copper-nickel couples were accurate to 1·8 microvolts, while those of copper-iron couples were accurate to less than one microvolt at moderate temperatures. The heating arrangement was designed to give a uniform temperature which was measured by a platinum thermometer and recorded automatically by Callendar's recorder. The cold junctions were placed in a large test-tube full of water, the test-tube being placed in a larger vessel also containing water. The temperature of the cold junctions varied with that of the room, and all observations were reduced to cold junction 0° C. Finally, in each case, observations were taken by placing the junctions in liquid air with the platinum thermometer beside them. To prevent oxidation of the metals forming the junctions at temperatures above 500° it was necessary to exhaust the porcelain tubes which contained them. The curves for variation of E.M.F. with temperature of copper-nickel and copper-iron couples are roughly a straight line and a parabola respectively. The differences between the actual curves and a selected straight line in the former case and a parabola in the latter case have been plotted against temperature. These difference curves show that the maximum variations occur, in the case of copper-iron, at 70°, 230°, and 370°. The temperature of inversion (cold junction 0° C.) is 536° C. and the neutral point is 262° C. In the case of copper-nickel, maximum variations occur at 70° and 340°, and there appears to be a small hysteresis effect at the latter point. The temperature of inversion does not occur within the limits of the experiments, and there is no neutral point. The E.M.F. curve for a nickel-iron couple up to 700° has been obtained from the two previous experimental curves by addition. Above this temperature direct observations have been taken. This curve is nearly linear up to 900°, at which point a decrease in E.M.F. occurs. Curves of thermoelectric power have been derived from the E.M.F. curves by drawing tangents, and these show that a considerable range of the copper-iron curve can be represented by straight lines, but that the remainder is approximately parabolic. The copper-nickel power curve can be represented by bits of straight lines. The Peltier-coefficient variation curve for iron-copper is at first parabolic and can then be made up of straight lines; for copper-nickel it can be made up of bits of parabolas. Considerable difficulty was experienced at high temperatures in getting concordant results owing to chemical changes and other effects. The experiments were therefore carried out under different conditions, and the results are discussed in the paper. In the resistance experiments a potentiometer method was employed, a manganin resistance coil immersed in an oil bath being used as a standard. The resistance of nickel increases with temperature almost parabolically up to 370°, when a change of slope occurs, and the resistance increases much less rapidly and almost linearly up to 1050°. In the case of iron, the resistance curve does not change its parabolic form till nearly 800°, when it becomes linear and remains so up to 1050°. The author concludes from his paper that the thermoelectric change in nickel-copper coincides approximately with the resistance change, but that no thermoelectric peculiarity exists for iron-copper at the temperature of the iron resistance change. Mr. A. Campbell said that with purer iron the change in thermoelectric properties might correspond with the change in resistance. Dr. Knott had performed experiments on nickel in 1886 and got results similar to those of the author. His results with thick wires were different to those with thin, probably because he did not exclude air and prevent oxidation. Mr. Campbell said that he had himself made experiments upon two samples of nickel differing in resistivity, and although their temperature coefficients were also different, the change in slope of the curve connecting resistance and temperature occurred at practically the same temperature in both specimens. Their thermoelectric powers were identical up to 300°, but above they differed slightly. Dr. D. K. Morris pointed out that the thermoelectric force, the resistance and the magnetic properties should be observed at the same time. In taking a thermoelectromotive force there must be a temperature gradient, and in the interesting parts of the curves differences of magnetic properties may arise and produce discrepancies. He drew attention to the caution which must be exercised in differentiating by drawing tangents except when the curves are smooth. Dr. Morris said the connection between resistance and magnetic qualities was interesting. The temperature coefficient of resistance of a magnetic body rises with temperature so long as the body is magnetic, but reverses when the body becomes non-magnetic. He asked for information on the subject. Prof. H. L. Callendar said he had followed the research with interest, and referred to the experimental difficulties, especially at high temperatures. He should like to have said something in reply to Dr. Morris, but he was afraid the subject was a large one and might well be discussed at some future meeting. There were several points to clear up, and the fact that the curves described cannot be represented by straight lines or parabolas showed that the subject was beyond the range of a simple theory. The chairman suggested that it might be well to re-examine more carefully some of the curves which are accepted as straight lines and on which there is no complication due to magnetic properties. He hoped the author and others would continue working at this subject. Mr. E. P. Harrison, in reply to Dr. Morris, said he thought the number and accuracy of his observations justified him in drawing tangents to form his power and Peltier-effect curves.—A paper on asymmetry of the Zeeman effect, by Mr. G. W. Walker, was read by the secretary. Prof. Voigt predicted an asymmetry of the normal triplet, which has been verified by Zeeman. The author has considered the subject mathematically, and finds that asymmetry may arise as a second order term due to the magnetic field. The asymmetry would be more distinct the greater the field, which is opposed to the theory of Voigt. By giving numerical values to the symbols it is shown that the effect is extremely small. The author points out that his theory can provide an explanation of why a line may not be resolvable.

PARIS.

Academy of Sciences, October 21.—M. Bouquet de la Grye in the chair.—The junction of a closed network of triangulation, by M. P. Hatt.—Researches on the mummified fishes of ancient Egypt, by MM. Lortet and Hugounenq. A description and chemical analyses of mummified specimens of *Lates niloticus*. The ash consisted largely of common salt and silicates. The fish are in a wonderful state of preservation, they appear to have been enclosed in a mixture of clay and sand impregnated with a large proportion of alkaline salts, especially sodium chloride.—On a new layer of mammifers of the middle Eocene at Robiac, near Saint-Mamert, by MM. Ch. Déperet and G. Carrière. An account of the discovery of a rich deposit of Eocene vertebrates at Robiac. The species identified include *Lophiodon rhinocerodes* and *isselensis*, *Paloplotherium magnum* and *lugdunense*, *Pachynolophus Duvali*, *Anchilophus Desmaresti*, and *Hyopotamus Gresslyii*.—The limit of chemical reactions and that of the product PV in gases, by M. A Ponsot.—The diameters of Jupiter obtained with the Brunner Equatorial of the Observatory of Lyons. The influence of magnification, by M. J. Guillaume. The value obtained for the apparent diameters of this planet differed slightly according to the magnification employed. A comparison of measurements of these diameters taken at different times by various astronomers shows that this effect is general.—On secondary chains, by M. G. Kœnigs.—On groups of substitutions, by M. G. A. Miller.—On linear differential equations of the second order with algebraical coefficients of the second and third species, by M. Paul J. Suchar.—On two particular classes of congruences of Ribaucour, by M. A. Demoulin.—On the variations of magnetisation in a cubical crystal, by M. Wallerant.—Action of the pyridine bases upon the tetra-halogen quinones, by M. Henry Imbert. The action of the pyridine bases upon chloranil and bromanil has been previously described. It is now shown that the resulting compounds still possess the quinonic function, as on reducing with sulphurous acid, hydroquinones are undoubtedly produced. The isolation and properties of the pyridyl compound are described.—On the oxidation of the benzene hydrocarbons by means of manganese peroxide and sulphuric acid, by M. H. Fournier. Toluic aldehyde was obtained as the oxidation product of ortho-xylene with these reagents. One of the methyl groups in pseudocumene was similarly oxidised to the aldehyde grouping, paracymene behaving similarly. With ethylbenzene the chief product was acetophenone, a little benzaldehyde being also produced.—The action of ammonia on benzyl chloride and on the conditions of formation of benzylamine, by M. René Dhommée. A study of the conditions under which the best yield of benzylamine can be obtained.—On the amine derived from the supposed binaphthylene glycol, by M. R. Fosse.—The nitro-derivatives of arabite and rhamnite; the constitution of certain nitrous esters, by MM. Leo Vignon and F. Gerin. The penta-nitro-derivative of arabite and the penta-nitro-rhamnite both readily reduce an alkaline copper solution. The cause in the differences in reducing power of various nitro-derivatives is accounted for by the authors by supposing a difference in constitution.—On glycerophosphorous acid and the glycerophosphites, by MM. Auguste Lumière, Louis Lumière and F. Perrin. A study of the acids and salts resulting from the action of phosphorus trichloride upon glycerine.—On a new microsporidium, *Pleistophora mirandellae*, a parasite of the ovary of *Alburnus mirandella*, by MM. C. Vaney and A. Conte.—Seasonal histolysis, by M. G. Bohn.—On some ferns with heterospores, by M. B. Renault.—The development of the embryo in the ivy (*Hedera helix*), by M. L. Ducamp. In the formation of the radicular cone the central cylinder remains apart from the suspender.—Retinal inertia relative to the sense of form, by MM. Andre Broca and D. Sulzer.

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 31.

ROYAL SOCIETY, at 4.30.—Special Joint Meeting with the Royal Astronomical Society, to receive Preliminary Reports on the Solar Eclipse of 1901.

CHEMICAL SOCIETY, at 8.30.—The Frankland Memorial Lecture: Prof. H. E. Armstrong, F.R.S.

FRIDAY, NOVEMBER 1.

GEOLOGISTS' ASSOCIATION, at 8.—A Conversazione in the Library of University College, Gower Street.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Adjourned Discussion on the Second Gas-Engine Research Report by Prof. F. W. Burstall.

MONDAY, NOVEMBER 4.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Rapid and Approximate Estimation of Free Oxygen in Sewage Effluents and Waters: Prof. W. Ramsay, F.R.S.—Phthalic Glyceride: Watson Smith.—Notes on the Manufacture of Varnish by the Pressure Process: A. J. Smith.

TUESDAY, NOVEMBER 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Address by Mr. Charles Hawksley, President, and Presentation of Medals and Prizes awarded by the Council.

WEDNESDAY, NOVEMBER 6.

GEOLOGICAL SOCIETY, at 8.—On an Altered Siliceous Sinter from Builth: Frank Rutley.—Note on a Submerged and Glaciated Rock-Valley recently exposed to view in Caermarthenshire: T. Codrington.—On the Clarke Collection of Fossil Plants from New South Wales: E. A. Newell Arber.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 7.

LINNEAN SOCIETY, at 8.—On the Life-history of the Black-currant Mite (*Phytoptus ribis*): Mr. Warburton and Miss Embleton.—Notes on the types of Species of *Carex* in Boott's Herbarium: C. B. Clarke, F.R.S.

RÖNTGEN SOCIETY, at 8.30.—Presidential Address: Herbert Jackson.

CHEMICAL SOCIETY, at 8.—Note on the Non-existence of a Higher Oxide of Hydrogen than the Di-oxide: Prof. W. Ramsay, F.R.S.—The Electrolytic Reduction of Nitrourea: G. W. F. Holroyd.—(1) The Constitution of Pilocarpine, III.; (2) A New Synthesis of α-Ethyl Tricarballylic Acid: H. A. D. Jowett.—The Action of Nitric Acid on Methyl Dimethylacetoacetate: Prof. W. H. Perkin, F.R.S.—(1) An Incrustation from the Stone Gallery of St. Paul's Cathedral; (2) Note on Asbestos: E. G. Clayton.—Liquid Nitrogen Peroxide as a Solvent: Prof. P. F. Frankland, F.R.S., and R. C. Farmer.

FRIDAY, NOVEMBER 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.

CONTENTS.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye." — WORDSWORTH.

No. 1644, Vol. 64] THURSDAY, MAY 2, 1901. [Price Sixpence

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1645, Vol. 64] THURSDAY, MAY 9, 1901. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

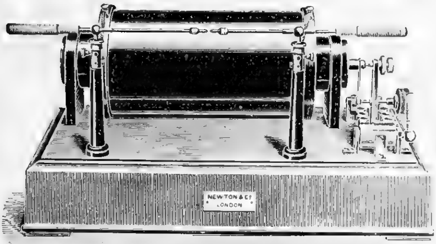
NATURE

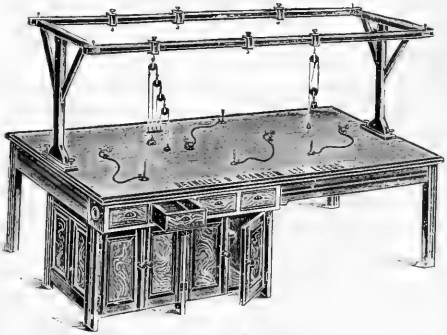
A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

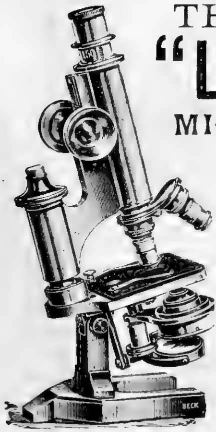
*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1646, VOL. 64] THURSDAY, MAY 16, 1901. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]







NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1647, Vol. 64] THURSDAY, MAY 23, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1648, VOL. 64] THURSDAY, MAY 30, 1901. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1649, Vol. 64] THURSDAY, JUNE 6, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NOTICE.

THE ISSUE OF

NATURE

FOR THURSDAY NEXT, JUNE 13, WILL CONTAIN THE

INDEX

TO VOLUME LXIII.

ITS PRICE WILL BE ONE SHILLING.

Advertisements intended for insertion in this Number should reach the Publishers by TUESDAY, JUNE 11.

OFFICE OF "NATURE,"
ST. MARTIN'S STREET, LONDON, W.C.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,

BURLINGTON HOUSE, LONDON, W.

The next ANNUAL MEETING of the ASSOCIATION will be held at GLASGOW, commencing on WEDNESDAY, SEPTEMBER 11.

PRESIDENT-ELECT:
Prof. A. W. RÜCKER, D.Sc., LL.D., Sec.R.S.

Information about local arrangements may be obtained on application to the LOCAL SECRETARIES, 30 George Square, Glasgow.

G. GRIFFITH, Assistant General Secretary.

UNIVERSITY OF BIRMINGHAM.

FACULTY OF SCIENCE.
RESEARCH SCHOLARSHIPS.
Each of the value of about £96.

(Founded by the late T. AUBREY BOWEN, Esq., of Melbourne, Australia).

(*a*) Two BOWEN SCHOLARSHIPS in ENGINEERING.
(*b*) One BOWEN SCHOLARSHIP in METALLURGY.
(*c*) Three PRIESTLEY SCHOLARSHIPS in CHEMISTRY.

The object of these Scholarships is to encourage Higher Work and Research in Scientific Professional Engineering and in Chemical and Metallurgical Science.

Applications, supported by details of educational training and references to former teachers and others, should be sent to the REGISTRAR on or before July 1, 1901. The Awards will be made in September next, and the Scholarships will be tenable during the Session 1901-2.

Further particulars may be obtained on application to the REGISTRAR.

COUNTY BOROUGH OF SUNDERLAND.

TECHNICAL COLLEGE.

Applications are invited for Four Lectureships in the following subjects at the above College, which will be opened for the first time in the ensuing Autumn:—

I.—Mechanical and Civil Engineering.
II.—Physics and Electrical Engineering.
III.—Chemistry.
IV.—Modern Languages (German and French).

Salary, £200 per annum each, with prospect of advance in salary and status. No Fees. Age not to exceed 35 years. Candidates must be qualified to give instruction equal in standard to that of a University College.

For further particulars, written application should be made to the PRINCIPAL.

Applications, with a duplicate set of not more than five testimonials, to be sent by post, addressed to "The Principal of the Technical College, Town Hall, Sunderland," to be delivered there not later than June 28, 1901.

By Order,
FRAS. M. BOWEY,
Town Clerk.

Town Hall, Sunderland,
June, 1901.

CITY OF NORWICH TECHNICAL INSTITUTE.

The Technical Instruction Committee of the Corporation of Norwich invite applications for the following Appointments:—

LECTURER IN CHEMISTRY. Salary, £150 per annum. Candidates must be under 26 years of age, and specially qualified in this subject.

LECTURER IN BUILDING CONSTRUCTION, and allied subjects. Salary, £150 per annum. Candidates must be under 30 years of age.

The last date for sending in applications for either Appointment is June 22.

Intending candidates should send a stamped addressed foolscap envelope to the undersigned for further particulars and application form.

WILLIAM GANNON, M.A.,
Principal.

June 4, 1901.

THE INDIAN GOVERNMENT requir

the services of an ELECTRICAL ENGINEER as PROFESSO on the Staff of the CIVIL ENGINEERING COLLEGE, SIBPU His duties will be to Lecture on Electrical and Mechanical Enginee ing, to Superintend the Workshops, and to be in general charge of t Dynamo House attached to the College. The Salary will be:—

Rs. 500-50-700 a month during the first five years,
Rs. 750-50-1000 a month during the next five years,
and eventually Rs. 1100 a month,

and until free quarters are provided a grant of Rs. 75 a month will allowed. Applications should be addressed to the SECRETARY, Publ Department, India Office, London, and should be received not lat than June 29 next.

India Office, Whitehall, May 28, 1901.

UNIVERSITY OF BIRMINGHAM.

FACULTY OF COMMERCE.

The Council invites applications for an organising Chair in connecti with the future Faculty of Commerce at an inclusive stipend of £750.

The Council does not wish to limit its choice by specifying in wh department the first Professor shall be a specialist, but assumes that it wi probably be in one or more of the following subjects:—Economics, Industri Organisation and Administration, Finance and Statistics, Commercial La or Commercial History.

Enquiries may be addressed to the Secretary of the University, an applications should be in his hands on or before June 20.

GEO. H. MORLEY, Secretary.

HARRIS INSTITUTE, PRESTON.

Principal: R. WALLACE STEWART, D.Sc., London.

The Council of the Harris Institute invite applications for the followin appointments:—

LECTURER IN MECHANICAL ENGINEERING. Salary, £15 per annum. Practical knowledge and experience of evening class teachin essential.

ASSISTANT LECTURER IN CHEMISTRY, with a special know ledge of Agricultural Chemistry and experience in Agricultural Analysi Salary, £140 per annum.

ASSISTANT LECTURER IN MATHEMATICS AND PHYSICS Salary, £120 per annum.

In each case the Appointment involves teaching in both Day and Evenin Classes. Duties will in each case commence in September. Further pa ticulars may be obtained on application to the SECRETARY.

Applications, accompanied by not more than three testimonials, should b sent on or before Monday, June 17, 1901, to

T. R. JOLLY, Secretary.

HARRIS INSTITUTE, PRESTON.

WANTED, a LABORATORY and LECTURE ROOM ATTEND ANT, with a good knowledge of Physical Laboratory work. Must be good mechanic with some knowledge of instrument making.

Apply to the PRINCIPAL, stating wages required, and giving full pa ticulars and references.

CENTRAL TECHNICAL SCHOOLS, TRURO, CORNWALL.

WANTED—TWO ASSISTANTS, for the Session commencin September 17, 1901.

One in Chemistry, at £80 per annum.
One in Natural Science, at £80 per annum.

The Chemical Assistant must be capable of undertaking a certain amoun of Analytical Work.

Particulars of the duties of each post can be obtained from the PRINCIPAL and the applications, with testimonials, should be sent to the SECRETARY o the Schools not later than June 17, 1901.

A. BLENKINSOP,
Secretary.

CITY OF BIRMINGHAM.

MUNICIPAL TECHNICAL SCHOOL.

The Corporation require the services, from September 1 next, of a MODERN LANGUAGE MASTER for the Day School. Conversational French and German required. English subjects, especially Elementary Mathematics, desirable. Salary, £130 per annum.

The latest date for sending in applications is June 17 next.

Full particulars and form of application will be forwarded on application to

GEO. MELLOR, Secretary.

Offices of the School, Suffolk Street,
May 24, 1901.

WANTED, An ASSISTANT in the County

Chemical Laboratory. He will be required to Analyse Sewage and Sewage Effluents, and also to examine into the Purification of Sewage by means of Bacterial Filters. Salary, £100 per annum. Applications, with Testimonials and References, to be sent not later than June 10, 1901, to the COUNTY ANALYST, Shirehall, Worcester.

For other Tutorial Advertisements see page lxv.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
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INDEX NUMBER.

No. 1650, Vol. 64] THURSDAY, JUNE 13, 1901. [Price One Shilling.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see pages lxxv. *and* lxxvi.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
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No. 1651, Vol. 64] THURSDAY, JUNE 20, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see pages lxxxviii. *and* lxxxix.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1652, Vol. 64] THURSDAY, JUNE 27, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see pages xcix. *and* c.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1653, Vol. 64] THURSDAY, JULY 4, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,

BURLINGTON HOUSE, LONDON, W.

The next ANNUAL MEETING of the ASSOCIATION will be held at GLASGOW, commencing on WEDNESDAY, SEPTEMBER 11.

PRESIDENT-ELECT:

Prof. A. W. RÜCKER, D.Sc., LL.D., Sec.R.S.

Information about local arrangements may be obtained on application to the LOCAL SECRETARIES, 30 George Square, Glasgow.

G. GRIFFITH, Assistant General Secretary.

BOROUGH OF LONGTON.

SUTHERLAND TECHNICAL INSTITUTE AND LONGTON HIGH SCHOOL.

HEADMASTER ... GEORGE GEORGE, F.I.C., F.C.S.

The Governors invite Applications for the following posts:—

1. MISTRESS FOR COOKERY AND DRESSMAKING.

   A Lady who has had some teaching experience, and is able to take some English subjects in a Junior Form, desirable. Commencing Salary, £60 to £70 per annum, according to qualifications.

2. ASSISTANT MISTRESS FOR ART SUBJECTS.

   One holding Art Class Teacher's Certificate, and qualified to give instruction in the Advanced Stage of Practical Plane and Solid Geometry. Every facility given to successful candidate for working for Art Master's Certificate. Salary, £60 to £70 per annum, according to qualifications.

3. ASSISTANT SCIENCE MASTER FOR PHYSICS AND CHEMISTRY.

   Good practical man desired, and one who has had experience in an Organised Science School. Salary, £120 per annum.

Applications, stating age, where educated, teaching experience and qualifications to teach above-mentioned subjects (and others if any), and enclosing copies of three recent Testimonials, to be sent to the undersigned, not later than July 20.

Successful Candidates will be required to teach both in the Day School of Science as well as in the Evening Technical School.

W. T. COPE,
Secretary to the Technical Instruction Committee.

Court House, Longton, Staffs.,
June 26, 1901.

CITY AND COUNTY BOROUGH OF BELFAST.

APPOINTMENT OF ART MASTERS.

The Library and Technical Instruction Committee desire to obtain the services of Four Masters for their School of Art, viz.:—

A HEAD MASTER, who must be a specialist either in Design or in Drawing from Life. Salary, £350.

A SECOND MASTER, with special experience in either of the before-named branches. Salary, £240.

A MASTER for PAINTING and STILL LIFE. Salary, £200.

A MODELLING MASTER. Salary, £160.

Information as to conditions of appointment, &c., may be obtained on application to the PRINCIPAL OF THE MUNICIPAL TECHNICAL INSTITUTE, Town Hall, Belfast, with whom applications, stating age, present engagement, &c, with copies of not more than three testimonials, should be lodged not later than Wednesday, July 17.

Canvassing will be a disqualification.

SAMUEL BLACK,
Town Clerk.

July 3, 1901.

UNIVERSITY OF TORONTO.

Applications, accompanied by testimonials, will be received by the undersigned until September 15, for Professorships in the following subjects:—

(1) GEOLOGY, including PALÆONTOLOGY.

(2) MINERALOGY and PETROGRAPHY.

The appointments will be made in the first instance for a period of three years, after which time they will be made permanent if the services of the appointees have been satisfactory. The initial salary is $2500, increasing by annual increments of $100 until a maximum of $3200 is reached. For further information apply to PRESIDENT LOUDON, c/o the High Commissioner for Canada, 17 Victoria Street, S.W.

RICHARD HARCOURT, Minister of Education.

Toronto, Ontario (Canada), June 1901.

WEST HAM MUNICIPAL TECHNICAL INSTITUTE.

WANTED, ASSISTANT DEMONSTRATOR in Physical Laboratory Classes for the Session 1901-1902. Two evenings a week.

F r further particulars apply to the PRINCIPAL, Municipal Technical ... titute, West Ham, E., to whom all applications must be made.

RATHMINES URBAN DISTRICT.

TECHNICAL SCHOOLS PRINCIPAL WANTED.

Notice is hereby given that the Technical Instruction Committee of Rathmines are prepared to consider applications from Candidates for the position of HEAD-MASTER or PRINCIPAL of the Technical Schools about to be established in the district. The Technical Schools will be mainly of a high-class Commercial type.

The salary will be £400 per annum.

No person need apply who has not had some scientific or technical training, as well as experience as teacher, in a Technical School.

Particulars as to duties, terms of appointment, &c., may be had on application to me.

Applications, accompanied by copies of testimonials, stating age, qualifications, and experience, should be sent to me before MONDAY, July 8, 1901.

By Order,
F. P. FAWCETT, Secretary.

Town Hall, Rathmines, June 21, 1901.

BALLYMENA URBAN DISTRICT COUNCIL.

MUNICIPAL TECHNICAL SCHOOL.

The Urban Council of Ballymena (population about 11,000) is promoting a Scheme of Technical Instruction under the provisions of the Agriculture and Technical Instruction (Ireland) Act, 1899. A HEADMASTER is Wanted whose duties will involve the organisation of Classes, the equipment of a suitable School, and advising the Committee on all subjects of Technical Instruction. The principal industries of the town are Spinning and Weaving, Ironfounding, Boot-making and Coach-building. The Headmaster must be qualified to give instruction in some Science and Art Subjects, as well as in some Subjects of Applied Science and Art on Trade Subjects. Probable salary, £250 per annum.

Applications, accompanied by nine copies of testimonials, to be forwarded to the TOWN CLERK, Ballymena, County Antrim, not later than July 15.

By Order,

HENRY O'HARA.

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR.

(A CONSTITUENT COLLEGE OF THE UNIVERSITY OF WALES.)

AGRICULTURAL CHEMISTRY.

Applications are invited for the post of ASSISTANT LECTURER AND DEMONSTRATOR IN AGRICULTURAL CHEMISTRY. Salary £120. Candidates will be required to show a sound general knowledge of Inorganic and Organic Chemistry.

Applications and Testimonials should be received not later than Monday, September 2, by the undersigned, from whom further particulars may be obtained.

JOHN EDWARD LLOYD, M.A.,
Secretary and Registrar.

Bangor, June 19, 1901.

CROYDON COUNTY POLYTECHNIC, CROYDON.

DEPARTMENT OF ELECTRICAL ENGINEERING.

The Committee require the services of an ASSISTANT LECTURER and DEMONSTRATOR in this Department. The person appointed will be required to attend on three evenings each week, and must be qualified to lecture in at least one branch of Electrical Engineering. Salary, £50 for the Session of about 30 weeks.

Applications with copies of testimonials must be sent to the undersigned, from whom further particulars of the appointment may be obtained, not later than Wednesday, July 10, 1901.

S. W. BICKELL, Secretary.

June 24, 1901.

ROYAL ALBERT MEMORIAL COLLEGE, EXETER.

The Governors will appoint a LECTURER as Head of the Department of MATHEMATICS and APPLIED PHYSICS.

Candidates must be graduates in honours of some English University and should have had experience of Class teaching and of Organising work.

Salary, £250 a year, with share of the Fees of Day Students in his department.

Canvassing the Governors will disqualify a candidate.

Applications and copies of testimonials should be sent before July 20 to the PRINCIPAL.

MUNICIPAL TECHNICAL SCHOOL, LEICESTER.

WANTED, in September, an INSTRUCTOR in ENGINEERING SUBJECTS. Day and Evening Classes. Salary, £150 per annum.

Apply to

ALFRED T. NEWBY,
Secretary.

For other Tutorial Advertisements see page cxii.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
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No. 1654, VOL. 64] THURSDAY, JULY 11, 1901. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

ENGINEERING AND CHEMISTRY.

CITY AND GUILDS OF LONDON INSTITUTE.

SESSION 1901–1902.

The Courses of Instruction at the Institute's Central Technical College (Exhibition Road) are for Students not under 16 years of age; those at the Institute's Technical College, Finsbury, for Students not under 14 years of age. The Entrance Examinations to both Colleges are held in September, and the Sessions commence in October. Particulars of the Entrance Examinations, Scholarships, Fees, and Courses of Study, may be obtained from the respective Colleges, or from the Head Office of the Institute, Gresham College, Basinghall Street, E.C.

CITY AND GUILDS CENTRAL TECHNICAL COLLEGE.

(Exhibition Road, S.W.)

A College for higher Technical Instruction for Day Students not under 16 preparing to become Civil, Mechanical, or Electrical Engineers, Chemical and other Manufacturers, and Teachers. Fee for a full Associateship Course, £30 per Session. Professors :—

Civil and Mechanical Engineering W. C. Unwin, F.R.S., M.Inst.C.E.
Electrical Engineering .. ... W. E. Ayrton, F.R.S., Past Pres. Inst.E.E.
Chemistry ... ... H. E. Armstrong, Ph.D., LL.D., F.R.S.
Mechanics and Mathematics ... O. Henrici, Ph.D., LL.D., F.R.S. (*Dean.*)

CITY AND GUILDS TECHNICAL COLLEGE, FINSBURY.

(Leonard Street, City Road, E.C.)

A College for Intermediate Instruction for Day Students not under 14 preparing to enter Engineering and Chemical Industries, and for Evening Students. Fees, £15 per Session for Day Students. Professors :—

Physics and Electrical Engineering S. P. Thompson, D.Sc., F.R.S. (Principal of the College.)
Mechanical Engineering and Mathematics ... ... W. E. Dalby, M.A., B.Sc., M.Inst.C.E.
Chemistry ... ... R. Meldola, F.R.S., F.I.C.

JOHN WATNEY, Hon. Secretary.

City and Guilds of London Institute,
Gresham College, Basinghall Street, E.C.

MUNICIPAL SCHOOL OF TECHNOLOGY, MANCHESTER.

DAY DEPARTMENTS FOR THE ENGINEERING, CHEMICAL, TEXTILE, AND BUILDING TRADES INDUSTRIES.

The Entrance Examinations for the Session 1901–1902 will be held on Thursday, July 18, at 10 a.m. An Entrance Examination will also be held on Thursday, September 12.

Particulars may be had from

J. H. REYNOLDS, Principal.

Princess Street, June 28, 1901.

GUY'S HOSPITAL.

PRELIMINARY SCIENTIFIC (M.B. London).

The next Course of Lectures and Practical Classes for this Examination will begin on October 1st. Candidates entering for this Course can register as Medical Students.

Full particulars may be obtained on application to the Dean, Guy's Hospital, London Bridge, S.E.

BOROUGH OF LONGTON.

SUTHERLAND TECHNICAL INSTITUTE AND LONGTON HIGH SCHOOL.

Headmaster ... GEORGE GEORGE, F.I.C., F.C.S.

The Governors invite Applications for the following posts :—

1. MISTRESS FOR COOKERY AND DRESSMAKING.
   A Lady who has had some teaching experience, and is able to take some English subjects in a Junior Form, desirable. Commencing Salary, £60 to £70 per annum, according to qualifications.

2. ASSISTANT MISTRESS FOR ART SUBJECTS.
   One holding Art Class Teacher's Certificate, and qualified to give instruction in the Advanced Stage of Practical Plane and Solid Geometry. Every facility given to successful candidate for working for Art Master's Certificate. Salary, £60 to £70 per annum, according to qualifications.

3. ASSISTANT SCIENCE MASTER FOR PHYSICS AND CHEMISTRY.
   Good practical man desired, and one who has had experience in an Organised Science School. Salary, £120 per annum.

Applications, stating age, where educated, teaching experience and qualifications to teach above-mentioned subjects (and others if any), and enclosing copies of three recent Testimonials, to be sent to the undersigned, not later than July 20.

Successful Candidates will be required to teach both in the Day School of Science as well as in the Evening Technical School.

W. T. COPE,
Secretary to the Technical Instruction Committee.

Court House, Longton, Staffs.,
June 26, 1901.

BIRKBECK INSTITUTION,

Breams Buildings, Chancery Lane, E.C.

Science Classes with Practical Work.

DAY AND EVENING COURSES for—

UNIVERSITY of LONDON.—B.Sc. Pass and Honours, Inter. Sci., Prelim. Sci., and Inter. M.B. (Chemistry) Examinations.

CONJOINT BOARD, DENTAL and **PHARMACEUTICAL EXAMINATIONS.**

HIGHLY EQUIPPED LABORATORIES, for—

CHEMISTRY, PHYSICS, BIOLOGY (ZOOLOGY and BOTANY), METALLURGY, GEOLOGY and MINERALOGY.

EVENING CLASSES in all BRANCHES of SCIENCE.

Prospectus free. Calendar 6d. (Post 8d.) on application to Secretary.

HEATHCOTE SCIENCE LABORATORIES.

COMMERCIAL and **SCIENTIFIC RESEARCH** work can be carried out in these Laboratories in **CHEMISTRY, ELECTRICITY,** General **PHYSICS** and **BACTERIOLOGY,** Röntgen Ray Work and Photography at any times suitable to workers. Private Laboratory if desired. Powerful **ELECTRIC** Currents. Private and Class Tuition in the above Subjects, and also in Geology and Mathematics.

THE DIRECTOR,
Heathcote Street, Gray's Inn Road.

BLACKROCK URBAN DISTRICT.

TECHNICAL SCHOOLS.

HEAD MASTER AND SECRETARY WANTED.

Notice is hereby given that the Technical Instruction Committee of Blackrock are prepared to consider applications from Candidates for the position of Head Master and Secretary of the Technical Schools about to be established in the District. The salary will be £200 per annum.

The selected Candidate will be required to undertake the general organisation of the Schools (which will be open to both sexes) and to generally supervise the working, as well as to do all the secretarial work of the Schools and Committee, including the keeping of Class Registers, Accounts, &c., and, in addition, to teach at least three Classes in each Session, in Science or Technology.

The person appointed must be prepared to enter on his duties not later than September 1, in order to prepare for the Session's work.

Applications, accompanied by copies of testimonials, stating age, qualifications, and experience in the management of, or as a teacher in Technical Schools, should be sent to me not later than Thursday, the 18th day of July, 1901.

By Order,

J. MOONEY,
Hon. Secretary.

Town Hall, Blackrock,
June 29, 1901.

CITY AND COUNTY BOROUGH OF BELFAST.

APPOINTMENT OF ART MASTERS.

The Library and Technical Instruction Committee desire to obtain the services of Four Masters for their School of Art, viz. :—

A HEAD MASTER, who must be a specialist either in Design or in Drawing from Life. Salary, £350.

A SECOND MASTER, with special experience in either of the before-named branches. Salary, £240.

A MASTER for PAINTING and STILL LIFE. Salary, £200.

A MODELLING MASTER. Salary, £160.

Information as to conditions of appointment, &c., may be obtained on application to the Principal of the Municipal Technical Institute, Town Hall, Belfast, with whom applications, stating age, present engagement, &c., with copies of not more than three testimonials, should be lodged not later than Wednesday, July 17.

Canvassing will be a disqualification.

SAMUEL BLACK,
Town Clerk.

July 3, 1901.

FOR SALE.—A LARGE SIZE DEAD BEAT REFLECTING GALVANOMETER by Hartmann and Braun. Sensitiveness, ·000000008 amp. Original price, £33. Absolutely new; £22.—Isenthal & Co., 85 Mortimer Street, W.

For other Tutorial Advertisements see pages cxxiii. *and* cxxiv.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1655, Vol. 64] THURSDAY, JULY 18, 1901. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see page cxxxvi.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" *To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1656, Vol. 64] THURSDAY, JULY 25, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see pages cxlviii *and* clii.

NATURE

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1657, Vol. 64] THURSDAY, AUGUST 1, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see pages clx. *and* clxiv.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
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No. 1658, VOL. 64] THURSDAY, AUGUST 8, 1901. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see pages clxxii *and* clxxiii.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1659, Vol. 64] THURSDAY, AUGUST 15, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

UNIVERSITY OF BIRMINGHAM.

1901–2.

DEPARTMENT OF ENGINEERING.

CHANCE CHAIR OF ENGINEERING.

Professor: F. W. BURSTALL, M.A., Cantab., M.I.C.E., M.I.M.E.
Lecturer on Mechanical Engineering: Vacant.
Lecturer on Electrical Engineering: D. K. MORRIS, Ph.D., A.I.E.E.
Assistant Lecturer: F. H. HUMMEL, A.M.I.C.E.
Demonstrator: JAMES P. WOOD, B.E.
Instructor in Wood Work: T. D. GARSCADDEN.
Instructor in Iron Work: F. H. A. HALL.

The full Courses extend over four years, and Students who enter after Matriculation and who pass successfully the Examinations at the end of each year will be entitled to the degree of Bachelor of Science in the branch of Engineering to which they devote themselves.

THE TECHNICAL ENGINEERING CLASSES INCLUDE:—

LECTURES on the Strength of Materials, Theory of Steam, Gas and other Heat Engines, Hydraulics, Machine Design, Strength of Structures, Distribution of Power.

DRAWING: Design of Tools, Prime Motors, Dynamos, and other forms of Machinery.

COURSES IN CIVIL ENGINEERING, including Constructional Work in Masonry and Steel, Railway Work, Dams, Bridges, and Water Engineering.

FIELD WORK: Practical Surveying in the Field throughout the Summer Term.

ENGINEERING LABORATORY: Determination of the Strength of Materials, including Compressive, Bending, Tensile, and Torsion Tests, Experimental Study of the Steam Engine and Boiler, Frictional Efficiency Tests, the Flow of Water over Weirs and through Orifices, &c.

LECTURES and DEMONSTRATIONS on all Branches of Electrical Engineering.

ELECTRICAL LABORATORY: Testing of Continuous and Alternate Current Machinery. Electrical Instruments, Meters, Lamps, and Batteries. Insulation and Magnetic Testing Work.

THE COURSES ALSO INCLUDE:—

Mathematics	Professor R. S. HEATH, M.A., D.Sc.
Physics	Professor J. H. POYNTING, D.Sc., F.R.S.
Chemistry	Professor PERCY F. FRANKLAND, B.Sc., Ph.D., F.R.S.
Geology...	Professor C. LAPWORTH, LL.D., F.R.S., F.G.S.
Metallurgy	Lecturer: G. MELLAND, B.Sc., A.R.S.M.

The SESSION 1901–2 commences on Tuesday, October 1, 1901.

Professor Burstall will attend to consult with intending students on October 1 from 10 a.m. to 1 p.m.

For DETAILED SYLLABUS, with full particulars of Fees, Scholarships, &c., apply to the Secretary of the University.

QUEEN'S COLLEGE, GALWAY.

The Matriculation Examination of Session 1901–1902 commences on October 18. Matriculation Certificates of any University within the United Kingdom are accepted.

All Lectures, Scholarships, Exhibitions, and Prizes are open to Students of either sex.

The Scholarship Examinations in Arts, Medicine, and Engineering commence on October 21.

DEPARTMENTS OF

SCIENCE, MEDICINE, AND ENGINEERING.

MATHEMATICS ...	Prof. Alfred C. Dixon, M.A., Sc.D., F.R.U.I., late Fellow of Trinity College, Cambridge
PHYSICS	Prof. A. Anderson, M.A., Hon. LL.D., Glasgow, late Fellow of Sidney Sussex College, Cambridge, President of the College.
CHEMISTRY	Prof. Alfred Senier, Ph.D., Berlin.
NATURAL HISTORY MINERALOGY, and GEOLOGY	Prof. Richard J. Anderson, M.A., M.D., M.R.C.S., Eng.
ENGINEERING... ...	Prof. Edward Townsend, M.A., D.Sc.
ANATOMY and PHYSIOLOGY	Prof. Joseph P. Pye, M.D., M.Ch., D.Sc., F.R.U.I.
PRACTICE of MEDICINE	Prof. John Isaac Lynham, M.D., M.Ch., M.A.O., F.R.U.I.
SURGERY...	Prof. W. W. Brereton, L.R.C.S.I., M.R.C.P.I.
MATERIA MEDICA ..	Prof. Nicholas W. Colohan, M.D., M.Ch.
GYNÆCOLOGY	Prof. Richard J. Kinkead, B.A., M.D., L.R.C.S.I.

Prospectus of the Courses and Regulations for Scholarships, &c., can be had on application to the

REGISTRAR,
Queen's College, Galway.

WANTED.—Berth in Chemical or Physical

Laboratory (former preferred), 14 years' experience. Expert Glass-blower.—Apply, "S. C. V.," Nature Office.

THE DAVY-FARADAY RESEARCH LABORATORY

OF THE

ROYAL INSTITUTION.

DIRECTORS:

The Right Hon. LORD RAYLEIGH, M.A., D.C.L., LL.D., F.R.S.
Professor DEWAR, M.A., LL.D., F.R.S.

Superintendent of the Laboratory:
Dr. ALEXANDER SCOTT, M.A., D.Sc., F.R.S.

This Laboratory was founded by Dr. Ludwig Mond, F.R.S., as a Memorial of Davy and Faraday, for the purpose of promoting, by original research, the development and extension of Chemical and Physical Science.

The Laboratory is open free of charge to Workers of either sex, and any nationality, prosecuting individual investigations; and the extensive collection of Physico-Chemical Apparatus presented by the Founder is available for their use, together with such materials, chemicals, electricity, &c., as the Directors may authorise.

Assistants and a trained mechanician are attached to the Laboratory to aid Workers in the prosecution of their researches.

All persons desiring to be admitted as Workers must send evidence of scientific training, qualification, and previous experience in original research, along with a statement of the nature of the investigation they propose to undertake.

Michaelmas Term.—Monday, October 7, to Saturday, December 14.
Lent Term.—Monday, January 6, to Saturday, March 22.
Easter Term.—Monday, April 14, to Saturday, July 26.

Forms of Application can be had from the Assistant Secretary, Royal Institution, Albemarle Street, W.

(VICTORIA UNIVERSITY.)

UNIVERSITY COLLEGE, LIVERPOOL.

DEPARTMENT OF ENGINEERING.

Session 1901–1902 commences October 3. Complete Courses of Instruction are arranged in

(1) Civil Engineering.
(2) Mechanical Engineering.
(3) Electrical Engineering.

These Courses enable Students to qualify for University Degrees, and for the College Certificates in Engineering. They comprise, in addition to special Engineering Lectures and Laboratory Work, instruction in Mathematics, Physics, Electrotechnics, and Chemistry.

Harrison Professor of Engineering	H. S. Hele-Shaw, LL.D., F.R.S., M.Inst.C.E.
Lyon Jones Professor of Experimental Physics	L. R. Wilberforce, M.A., Trinity College, Cambridge.
Professor of Mathematics	F. S. Carey, M.A., late Fellow of Trinity College, Cambridge.
Grant Chair of Chemistry	J. Campbell Brown, D.Sc., F.I.C.
Electrotechnics	E. W. Marchant, D.Sc.

The special Engineering Prospectus can be obtained on application to the Secretary.

VICTORIA UNIVERSITY.

THE YORKSHIRE COLLEGE, LEEDS.

The 28th Session of the Department of Science, Technology, Arts and Law, and the 71st Session of the School of Medicine, will begin on October 1, 1901.

The Classes prepare for the following Professions: Chemistry, Civil, Mechanical, Electrical, and Sanitary Engineering, Mining, Textile Industries, Dyeing, Art, Leather Manufacture, Agriculture, School Teaching, Law, Medicine, and Surgery.

University Degrees are also conferred in the Faculties of Arts, Science, Law, Medicine, and Surgery.

Lyddon Hall has been established for Students' residence.

Prospectus of any of the above may be had from the Registrar of the College.

THE YORKSHIRE COLLEGE, LEEDS.

DEPARTMENTS OF CIVIL, MECHANICAL AND ELECTRICAL ENGINEERING.

The Twenty-eighth Session will begin October 1, 1901.
Prospectus may be obtained from the Registrar.

METHODIST COLLEGE, BELFAST.

WANTED a Competent TEACHER for the TECHNICAL INSTRUCTION DEPARTMENT (Physics, Chemistry, &c.).

Apply, with copies of testimonials and salary expected, to Rev. Dr. Nicholas, President, Methodist College, Belfast.

For other Tutorial Advertisements see pages clxxxiv. *and* clxxxv.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
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No. 1660, VOL. 64] THURSDAY, AUGUST 22, 1901. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see page cxcvi.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1661, Vol. 64] THURSDAY, AUGUST 29, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

(VICTORIA UNIVERSITY.)

UNIVERSITY COLLEGE, LIVERPOOL.

DEPARTMENT OF ENGINEERING.

Session 1901–1902 commences October 3. Complete Courses of Instruction are arranged in

(1) Civil Engineering.
(2) Mechanical Engineering.
(3) Electrical Engineering.

These Courses enable Students to qualify for University Degrees, and for the College Certificates in Engineering. They comprise, in addition to special Engineering Lectures and Laboratory Work, instruction in Mathematics, Physics, Electrotechnics, and Chemistry.

Harrison Professor of Engineering	H. S. Hele-Shaw, LL.D., F.R.S., M.Inst.C.E.
Lyon Jones Professor of Experimental Physics	L. R. Wilberforce, M.A., Trinity College, Cambridge.
Professor of Mathematics	F. S. Carey, M.A., late Fellow of Trinity College, Cambridge.
Grant Chair of Chemistry	J. Campbell Brown, D.Sc., F.I.C.
Electrotechnics	E. W. Marchant, D.Sc.

The special Engineering Prospectus can be obtained on application to the Secretary.

ST. THOMAS'S HOSPITAL MEDICAL SCHOOL,

ALBERT EMBANKMENT, LONDON, S.E.

The WINTER SESSION of 1901-1902 will open on WEDNESDAY, October 2, when the prizes will be distributed at 3 p.m. by Major-General Sir Ian Hamilton, K.C.B., in the Governors' Hall.

St. Thomas's Hospital being one of the Medical Schools of the University of London, provision is made for the courses of study prescribed for the Preliminary Scientific, Intermediate and Final Examinations in Medicine.

Three Entrance Scholarships will be offered for competition in September, viz., one of £150 and one of £60 in Chemistry and Physics, with either Physiology, Botany, or Zoology, for first year's Students; one of £50 in Anatomy, Physiology, Chemistry (any two), for third year's Students from the Universities.

Scholarships and money prizes are awarded at the Sessional Examinations, a well as several medals.

All Hospital Appointments are open to Students without charge.

Club Rooms and an Athletic Ground are provided for Students.

The School Buildings and the Hospital can be seen on application to the Medical Secretary.

The Fees may be paid in one sum or by instalments. Entries may be made separately to Lectures or to Hospital Practice, and Special Arrangements are made for Students entering from the Universities and for Qualified Practitioners.

A Register of approved Lodgings is kept by the Medical Secretary, who also has a List of Local Medical Practitioners, Clergymen, and others who receive Students into their houses.

For Prospectus and all particulars apply to Mr. Rendle, the Medical Secretary.

H. G. TURNEY, M.A., M.D. Oxon., Dean.

UNIVERSITY OF BIRMINGHAM.

FACULTY OF MEDICINE.

Regulations concerning the various Degrees conferred by this University, and the requisite Courses of Instruction given at the same, and at the Hospitals of the City, will be found in the Syllabus of the Medical Faculty, which can be obtained Gratis on application to Messrs. Cornish Brothers, Booksellers, New Street, Birmingham, or to Geo. H. Morley, Secretary of the University.

The Syllabus gives all information as to

I. DEGREES IN MEDICINE.
II. DEGREE AND DIPLOMA IN PUBLIC HEALTH.
III. DEGREES IN DENTISTRY.

The WINTER SESSION will Commence on Tuesday, October 1.

The Dean (Professor Windle, M.D., D.Sc., F.R.S.) will see parents and Students on September 26, 27 and 30, between the hours of ten and one, also on October 1 and 2, at the same hours, and from two o'clock until three in the afternoon. The Courses of Instruction, though mainly arranged in accordance with the regulations of the University, qualify also for the examinations of other British Universities and for those of all the Licensing Corporations.

ALL DEGREES AND COURSES OF INSTRUCTION ARE OPEN TO MEN AND WOMEN ALIKE.

For information as to Entrance Scholarships see the Syllabus.

There are also Faculties of Science and Arts. Syllabuses, containing full particulars, are published separately.

THE LONDON SCHOOL OF TROPICAL MEDICINE

(UNDER THE AUSPICES OF HIS MAJESTY'S GOVERNMENT), CONNAUGHT ROAD, ALBERT DOCK, E.

In connection with the Hospitals of the Seamen's Hospital Society.

Sessions commence October 1, January 15, and May 1. For Prospectus, Syllabus, and other particulars, apply to the Secretary, P. Michelli, Esq., Seamen's Hospital, Greenwich, S.E.

UNIVERSITY COLLEGE, LONDON.

The Session of the Faculty of Medicine will commence on October 1. Introductory Lecture, at 4 p.m., by Prof. J. Risien Russell, M.D., F.R.C.P., Professor of Medical Jurisprudence.

The Examinations for the Entrance Scholarships and Medical Exhibitions will commence on September 25.

The Annual Dinner will be held on October 1, Sir Richard Douglas Powell, Bart., in the Chair.

Scholarships, Exhibitions, and Prizes of the value of £800 are awarded annually.

In University College Hospital about 3000 In-patients and 35,000 Out-patients are treated during the year. Thirty-six Appointments, eighteen being resident (as House Surgeon, House Physician, Obstetric Assistant, &c.), are filled up by competition during the year, and these, as well as all Clerkships and Dresserships, are open to Students of the Hospital without extra fee. Resident Officers receive free board and lodging.

Prospectuses, with full information as to Classes, Prizes, &c., may be obtained from University College, Gower Street, W.C.

J. R. BRADFORD, M.D., D.Sc., F.R.S., Dean.
T. GREGORY FOSTER, Ph.D., Secretary.

ST. BARTHOLOMEW'S HOSPITAL AND COLLEGE.

PRELIMINARY SCIENTIFIC CLASS.

Systematic Courses of Lectures and Laboratory Work in the subjects of the Preliminary Scientific and Intermediate B.Sc. Examinations of the University of London will commence on October 1, and continue till July, 1902. Attendance on this Class counts as part of the Five Years' Curriculum.

Fee for the whole Course, £21, or £18 18s. to Students of the Hospital; or single Subjects may be taken.

There is a Special Class for the January Examination.

For further particulars apply to the Warden of the College, St. Bartholomew's Hospital, London, E.C.

A Handbook forwarded on application.

VICTORIA UNIVERSITY.

THE YORKSHIRE COLLEGE, LEEDS.

The 28th Session of the Department of Science, Technology, Arts and Law, and the 71st Session of the School of Medicine, will begin on October 1, 1901.

The Classes prepare for the following Professions: Chemistry, Civil, Mechanical, Electrical, and Sanitary Engineering, Mining, Textile Industries, Dyeing, Art, Leather Manufacture, Agriculture, School Teaching, Law, Medicine, and Surgery.

University Degrees are also conferred in the Faculties of Arts, Science, Law, Medicine, and Surgery.

Lyddon Hall has been established for Students' residence.

Prospectus of any of the above may be had from the Registrar of the College.

THE YORKSHIRE COLLEGE, LEEDS.

DEPARTMENTS OF CIVIL, MECHANICAL AND ELECTRICAL ENGINEERING.

The Twenty-eighth Session will begin October 1, 1901.

Prospectus may be obtained from the Registrar.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,

BURLINGTON HOUSE, LONDON, W.

The next ANNUAL MEETING of the ASSOCIATION will be held at GLASGOW, commencing on WEDNESDAY, SEPTEMBER 11.

President-Elect:
Prof. A. W. RÜCKER, D.Sc., LL.D., Sec.R.S.

Information about local arrangements may be obtained on application to the Local Secretaries, 30 George Square, Glasgow.

G. GRIFFITH, Assistant General Secretary.

BRITISH MUSEUM.

The Reading Rooms will be Closed from Monday, September 2, to Thursday, September 5, inclusive.

British Museum, August 26, 1901.

E. MAUNDE THOMPSON, Director and Principal Librarian.

UNIVERSITY COLLEGE, SHEFFIELD.

Applications are invited for the post of JUNIOR DEMONSTRATOR IN CHEMISTRY, vacant by the appointment of Dr. Price to the Lectureship in Chemistry at Birmingham University. Salary, £100. Testimonials to be sent in before September 21.

For further information apply to the Registrar, University College, Sheffield.

For other Tutorial Advertisements see page ccviii.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1662, Vol. 64] THURSDAY, SEPTEMBER 5, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

UNIVERSITY OF EDINBURGH.

Principal—**Sir WILLIAM MUIR, K.C.S.I., D.C.L., LL.D., Ph.D., &c.**

The WINTER SESSION opens on 15th October (Practical Anatomy 1st October), and closes on 22nd March. The SUMMER SESSION opens at the beginning of May, and closes about the middle of July.

FACULTY OF MEDICINE.

Dean—Professor A. R. SIMPSON, M.D.

The Faculty embraces thirteen Chairs and eight Lectureships; and attached to these Chairs there are about thirty Assistants and Demonstrators. Instruction is given in all the branches of Medical Science, viz.:—

Professors.

Chemistry—Alex. Crum Brown, M.D., D.Sc. LL.D.
Zoology—J. Cossar Ewart, M.D.
Botany—Isaac Bayley Balfour, M.D., D.Sc.
Physics—J. G. MacGregor, M.A.
Anatomy—Sir William Turner, M.B., D.C.L., LL.D.
Physiology—E. A. Schäfer, LL.D.
Materia Medica—T. R. Fraser, M.D., LL.D.
Pathology—William S. Greenfield, M.D.
Public Health—C. Hunter Stewart, M.D., D.Sc.
Forensic Medicine—Sir Henry D. Littlejohn, M.D., LL.D.
Medicine—John Wyllie, M.D., LL.D.
Surgery—John Chiene, M.D.
Midwifery—Alexander Russell Simpson, M.D.
Clinical Surgery—Thomas Annandale, M.D.
Clinical Medicine—T. R. Fraser, M.D., Wm. S. Greenfield, M.D., John Wyllie, M.D., A. R. Simpson, M.D. (on Diseases of Women).

University Lecturers.

Mental Diseases—T. S. Clouston, M.D.
Diseases of the Eye—G. A. Berry, M.B.
Clinical Instruction on Diseases of Children—Staff of Royal Hospital for Sick Children.
Embryology and Vertebrate Zoology—J. Beard, D.Sc.
Regional Anatomy—D. Hepburn, M.D.
Advanced Practical Physiology—T. H. Milroy, M.D., B.Sc.
Experimental Pharmacology—W. C. Sillar, M.B., B.Sc.
Pathological Bacteriology—J. M. Beattie, M.D.
Physics—C. G. Knott, M.A., D.Sc.
Diseases of the Larynx, Ear, and Nose—P. M'Bride, M.D.
Tropical Diseases—A. Davidson, M.D.
Diseases of the Skin—W. Allan Jamieson, M.D.

Practical Instruction is afforded, under the superintendence of the Professors, in Laboratories with the necessary appliances, and in Tutorial and Practical Classes connected with the above Chairs, and opportunities are afforded to Students and Graduates to extend their practical knowledge and engage in original research.

Opportunities for Hospital Practice are afforded at the Royal Infirmary, the Hospital for Sick Children, Maternity Hospital, the City Hospital, and the Asylum for the Insane. Upwards of 1500 beds are available for the Clinical Instruction of Students of the University.

Four Degrees in Medicine and Surgery are conferred by the University of Edinburgh, viz., Bachelor of Medicine (M.B.), Bachelor of Surgery (Ch.B.), Doctor of Medicine (M.D.), and Master of Surgery (Ch.M.); and Diplomas in Special Branches of Medical and Surgical Practice may also be conferred on Graduates in Medicine and Surgery of the University.

The minimum Class Fees for M.B. and Ch.B., including Hospital Fee (£12) amount to about £115, and the Matriculation and Examination Fees to £28 7*s*. An additional Fee of £10 10*s*. is payable by those who proceed to M.D., and £10 10*s*. by those who proceed to Ch.M.

The annual value of the Bursaries, Prizes, Scholarships, and Fellowships in the Faculty of Medicine amounts to about £3600, and that of the other Bursaries, &c., tenable by Students of Medicine, amounts to about £1820.

Instruction is also given in Public Health, and the Degrees of B.Sc. and D.Sc. in Public Health are conferred by the University.

Residences for Students, Graduates, and others, situated within easy reach of the University, afford excellent board and lodging on very moderate terms.

Further information as to Matriculation, the Curricula of Study for Degrees, &c., may be obtained from the Dean of the Faculty of Medicine; or from the Clerk of Senatus; and full details are given in the University Calendar, published by James Thin, 55 South Bridge.

August, 1901.

By authority of the Senatus, L. J. GRANT, Secretary of Senatus.

UNIVERSITY COLLEGE OF NORTH WALES (BANGOR).

SESSION 1901-2 will open on TUESDAY, OCTOBER 1.

DEPARTMENTS of PHYSICS, CHEMISTRY, and BIOLOGY.

PHYSICS .... Prof. E. Taylor Jones, D.Sc. Assistant Lecturers and Demonstrators, T. C. Baillie, M.A., D.Sc., and W. W. Firth, M.Sc.

CHEMISTRY ... Prof. J. J. Dobbie, M.A., D.Sc. Assistant Lecturer and Demonstrator, A. Lauder, B.Sc.

BIOLOGY ...... Botany—Prof. R. W. Phillips, M.A., D.Sc. ,, Assistant Lecturer and Demonstrator, J. Lloyd Williams. Zoology—Prof. Philip J. White, M.B., F.R.S.E.

The Classes and Laboratory Courses of this College are arranged to suit the requirements of Students of Practical Science, as well as of Students preparing for University and other Examinations. The Lectures in Chemistry, Physics, Botany, and Zoology are recognised by the Universities of Edinburgh and Glasgow as qualifying for the Medical Degrees of those Universities. One *Annus Medicus* may be taken at this College.

The extensive Laboratories (Physical, Chemical, and Biological) are fully equipped for Study and Research, and in the Physical Department special provision has been made for the teaching of Electrical Engineering. A Special Course has been arranged in this subject.

Inclusive Tuition Fee, £11 1*s*.

LABORATORY FEES (per Term)

on the scale of £1 1*s*. for six hours a week, in each Department.

A considerable number of Scholarships and Exhibitions are open for competition at the beginning of each Session, and several are awarded at the close of each Session on the result of the year's work.

For full information as to Courses, apply for Prospectus to the Secretary and Registrar,

J. E. LLOYD, M.A.

NORTHAMPTON INSTITUTE, CLERKENWELL, LONDON, E.C.

ENGINEERING DAY COURSES IN MECHANICAL, ELECTRICAL AND HOROLOGICAL ENGINEERING.

FULL DAY COURSES in the above subjects will commence on MONDAY, September 30, 1901. ENTRANCE EXAMINATION on WEDNESDAY and THURSDAY, September 25 and 26. Particulars of the Courses can be obtained on application at the Office of the Institute, or to

R. MULLINEUX WALMSLEY, D.Sc., Principal.

☞ *New Session commences 30th September.*

BIRKBECK INSTITUTION,

Breams Buildings, Chancery Lane, E.C.

Principal: G. ARMITAGE-SMITH, M.A.

Science Classes with Practical Work.

DAY AND EVENING COURSES for—

UNIVERSITY of LONDON.—B.Sc. Pass and Honours, Inter. Sci., Prelim. Sci., and Inter. M.B. (Chemistry) Examinations.

CONJOINT BOARD, DENTAL and **PHARMACEUTICAL EXAMINATIONS.**

COMPLETE DAY COURSE IN METALLURGY AND MINING.

HIGHLY EQUIPPED LABORATORIES, for—

CHEMISTRY, PHYSICS, BIOLOGY (ZOOLOGY and BOTANY) METALLURGY, GEOLOGY and MINERALOGY.

EVENING CLASSES in all BRANCHES of SCIENCE.

Prospectus free. Calendar 6d. (Post 8d.) on application to Secretary

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BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,

BURLINGTON HOUSE, LONDON, W.

GLASGOW MEETING, September 11 to 18, 1901.

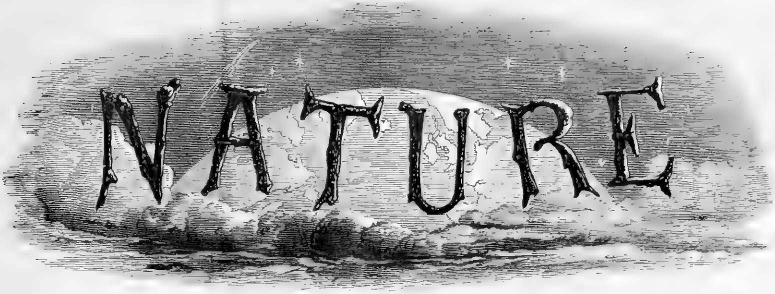
President-Elect:

Prof. A. W. RÜCKER, D.Sc., LL.D., Sec.R.S.

The Journal, President's Address, and other Printed Papers issued by the Association during the Annual Meeting will be forwarded daily by post to Members and others unable to attend, on application and prepayment of 2*s*. 6*d*. to the Clerk of the Association, Mr. H. C. Stewardson, Reception Room, The University, Glasgow, on or before the first day of the Meeting.

G. GRIFFITH, Assistant General Secretary.

For other Tutorial Advertisements see pages ccxx *and* ccxxv.



A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1663, Vol. 64] THURSDAY, SEPTEMBER 12, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see pages ccxxxii *and* ccxxxviii.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1664, Vol. 64] THURSDAY, SEPTEMBER 19, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see page ccxlviii.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1665, VOL. 64] THURSDAY, SEPTEMBER 26, 1901. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see page cclx.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1666, VOL. 64] THURSDAY, OCTOBER 3, 1901. [PRICE SIXPENCE.

For other Tutorial Advertisements see page cclxxii.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1667, VOL. 64] THURSDAY, OCTOBER 10, 1901. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

For other Tutorial Advertisements see page ccxciii.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*" To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1668, VOL. 64] THURSDAY, OCTOBER 17, 1901. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

For other Advertisements similar to above, see page cccvi.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1669, Vol. 64] THURSDAY, OCTOBER 24, 1901. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

For other Advertisements similar to above see page cccxviii.

NATURE

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COUNTY BOROUGH OF SUNDERLAND TECHNICAL COLLEGE.

Owing to the large influx of Students at the above College, recently opened, additional teaching staff is required. Applications are therefore invited for the following posts:—

I. ASSISTANT LECTURER IN MATHEMATICS. Salary, £150 per annum.

II. DEMONSTRATOR IN PHYSICS AND ELECTRICAL ENGINEERING. Salary, £120 per annum.

III. DEMONSTRATOR IN CHEMISTRY. Salary, £120 per annum

IV. DEMONSTRATOR IN ENGINEERING. Salary, £120 per annum.

V. ASSISTANT LECTURER IN GERMAN. Salary, £120 per annum.

Prospect of advance in Salary.

Age not to exceed [illegible] years. *Candidates must be qualified to give instruction equal in standard to that of a University College.*

For further particulars, written application should be made to the Secretary

Applications, with a duplicate set of not more than five testimonials, to be sent by post, addressed to Secretary, Technical College, Sunderland, with the particular post applied for named in the bottom left-hand corner of the envelope, and to reach the College not later than Monday, November 4, 1901.

By order,
FRAS. M. BOWEY, Town Clerk.

Town Hall, Sunderland,
October 15, 1901.

BALLIOL COLLEGE, CHRIST CHURCH, AND TRINITY COLLEGE, OXFORD.

NATURAL SCIENCE SCHOLARSHIPS AND EXHIBITIONS.

A Combined Examination for Natural Science Scholarships and Exhibitions will be held by the above Colleges, beginning on TUESDAY, DECEMBER 3, 1901.

Three Scholarships and three Exhibitions will be offered; with one exception the value of these endowments will be £80 a year.

The Subjects for Examination will be Physics, Chemistry, and Biology. Candidates will not be expected to offer themselves in more than two of these.

Particulars may be obtained by application to
Christ Church, Oxford. A. VERNON HARCOURT.

MAGDALEN COLLEGE, OXFORD.

NATURAL SCIENCE DEMYSHIPS AND EXHIBITIONS.

There will be an Examination at this College, commencing on December 10, 1901, with a view to electing to Two or More Demyships and Exhibitions in Natural Science.

Persons will be eligible for the Demyships who will not have exceeded the age of nineteen years on the day of Election, December 19, 1901, and for the Exhibitions who will not have exceeded the age of twenty-one years on the day of Election, December 19, 1901.

Candidates for these Demyships and Exhibitions will be required to pass such an Examination in Classics and Mathematics as will show their ability to pass hereafter in Responsions or an equivalent Examination.

For particulars of the Examination apply to the President, or the Natural Science Tutor, Magdalen College, who will forward a printed circular of details.

SIR JOHN CASS'S TECHNICAL INSTITUTE.

Principal: CHARLES A. KOHN, M.Sc., Ph.D.

The Governors of the Sir John Cass Foundation invite applications for the post of HEAD of the DEPARTMENT of PHYSICS and MATHEMATICS. Salary £250.

Applications, with copies of not more than three recent testimonials, must be sent in not later than November 9, addressed to the undersigned, from whom full details of the appointment may be obtained.

W. H. DAVISON,
Clerk to the Foundation,
Jewry Street, Aldgate, E.C.

BOROUGH OF SHREWSBURY.

The Technical Instruction Committee invite APPLICATIONS for the Post of ASSISTANT ART MASTER, qualified to teach Model, Freehand, and Geometrical Drawing. Applicants must have passed 1st Class in Advanced Building Construction (or Honours), Science and Art Department. Salary, £80, rising £10 per annum to £100, with liberty to accept employment under the County Council, or otherwise, at such times as not to interfere with duties at the Technical School, but subject to approval by the Committee. Personal canvassing will disqualify.

Applications, stating qualifications, when applicant could commence his duties, and with copies of testimonials (which will not be returned), marked "Art," to be sent not later than November 1, 1901, to

J. WILLIAMS, Secretary.

Guildhall, Shrewsbury, October 15, 1901.

BIRKBECK INSTITUTION,

Breams Buildings, Chancery Lane, E.C.

Principal: G. ARMITAGE-SMITH, M.A.

Science Classes with Practical Work.

DAY AND EVENING COURSES for—

UNIVERSITY of LONDON.—B.Sc. Pass and Honours, Inter. Sci., Prelim. Sci., and Inter. M.B. (Chemistry) Examinations.

CONJOINT BOARD, DENTAL and **PHARMACEUTICAL EXAMINATIONS.**

COMPLETE DAY COURSE IN METALLURGY AND MINING.

HIGHLY EQUIPPED LABORATORIES, for—

CHEMISTRY, PHYSICS, BIOLOGY (ZOOLOGY and BOTANY), METALLURGY, GEOLOGY and MINERALOGY.

EVENING CLASSES in all BRANCHES of SCIENCE.

Prospectus free. Calendar (Session 1901–2) 6d. By post 8d.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

JUNIOR DEMONSTRATORSHIP IN PHYSICS.

The Council invite applications for the post of JUNIOR DEMONSTRATOR in the DEPARTMENT of PHYSICS at the above College.

Applications, with testimonials, should be sent not later than Monday, November 11, 1901, to the undersigned, from whom further particulars may be obtained.

October 1901. T. MORTIMER GREEN,
Registrar.

NORTHAMPTON INSTITUTE,

CLERKENWELL, LONDON, E.C.

The Governing Body invite Applications for the appointment of HEA[illegible] of the DEPARTMENT of MECHANICAL ENGI[illegible] METAL TRADES, rendered vacant [illegible] Ashford, M.I.M.E., who is retiring fr[illegible] mencing salary is £250 per annum, and [illegible] Candidate should be in a position to ent[illegible]

Applications should be received no[illegible] November 12, 1901. The conditions of [illegible] tion may be obtained by written applic[illegible] at the Institute.

R. MULLINEU[illegible]

TECHNICAL COLLE[illegible] HUDDERSFIELD.

Principal ... ... S. G. RAWSON, D.Sc.

The ASSISTANT LECTURESHIP in ENGINEERING is Vacant. Applications to be sent in to the Principal not later than November 4. Statement of duties and other particulars may be had upon application to

THOS. THORP, Secretary.

BIRMINGHAM SCHOOL BOARD.

The Board requires the services of an ASSISTANT MASTER for the Waverley Road Higher Grade School. Salary £100 to £145, according to qualifications and experience. The successful candidate will be required to teach Chemistry to the scholars of the School of Science.

Form of application may be obtained from the undersigned.

JNO. ARTHUR PALMER,
Clerk of the Board.

School Board Office, Edmund Street,
October 22, 1901.

HARRIS INSTITUTE, PRESTON.

ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSICS AND APPLIED ELECTRICITY.

Applications are invited for the post of Assistant Lecturer and Demonstrator in Physics and Applied Electricity. Duties to commence in November. Salary, £120.

Applications should be sent in at once.

Further particulars may be obtained on application to

T. R. JOLLY, Secretary.

AN OPPORTUNITY OCCURS TO RE-

ceive into a first-class firm of Scientific Instrument Makers, a gentleman's son, with a view to learning the business. Premium required.—Full particulars on application to "Science," Nature Office.

For other Advertisements similar to above, see page cccxxiv.